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ABSTRACT

The purpose of this document is to provide a context for the identification of issues that will be critical to the long-term future of public education in the United States and central to the long-term commitments and investments of the National Education Association. This paper is divided into three basic components. Part 1, "Inevitable Forces For Change--1985 to 1995," summarizes the major demographic, economic, and technologic trends and developments that will shape the educational operating environment during the next 10 years. Part 2, "Human Capital Economic Development, and Public Education in the Decade Ahead," examines the key linkages between public education and its changing environment, with special concentration on the educational functions and factors that will be instrumental in facilitating the nation's successful adaptation to post-industrial realities. Part 3, "Imperatives and Opportunities for Educators," synopsizes the fundamental tasks which education will be called upon to perform during the coming decade and describes the basic range of alternatives that will be open to educators in accomplishing each of these tasks. Following part 3, there is a set of exhibits containing references cited in the body of the documents. (SM)

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The Strategic Context of Education in America 1985-1995

DAVID PEARCE SNYDER

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FOREWARD

One of the major objectives of our planning activities is to help the Association become more proactive. To do this, we must look ahead, identify developing issues, and initiate action today so we are not merely reactive tomorrow.

"The Strategic Context of Education in America 1985-1995", written by futurist, David Pearce Snyder, is designed to stimulate thinking about what lies ahead for education and the Association.

This paper is only a starting point. Ultimately, the collective thought and experience of Association leaders will determine the issues which need organizational attention and decide on the actions to be taken.

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November 1984

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THE STRATEGIC CONTEXT OF EDUCATION IN AMERICA
1985 TO 1995

The purpose of this document is to provide a context for the identification of issues that will be critical to the long-term future of public education in America, and thus, central to the long-term commitments and investments of the National Education Association. To achieve this purpose, the following paper is divided into three basic components. Part I, "Inevitable Forces For Change," summarizes the major demographic, economic and technologic trends and developments that will shape the educational operating environment during the next 10 years. Part II, "Human Capital and Economic Development," examines the key linkages between public education and its changing environment, with special concentration on the educational functions and factors that will be instrumental in facilitating the nation's successful adaptation to post-industrial realities.

Part III, "Imperatives and Opportunities for Educators," synopsizes the fundamental tasks which education will be called upon to perform during the coming decade, and describes the basic range of alternatives that will be open to educators in accomplishing each of these tasks. Following Part III, there is a set of Exhibits containing references cited in the body of the document.

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PART I

INEVITABLE FORCES FOR CHANGE -- 1985 TO 1995

During the past decade, scholarly research has been conducted into the relative accuracy of different forecasting methodologies used within various fields or disciplines. This research has given us the first rigorous definitions of what we can know about the future with any useful degree of certainty. These research findings indicate that demography provides the longest range accuracy in forecasting; demographic projections may be regarded as statistically reliable up to 15 years into the future. Technological forecasts are usefully accurate from 7 to 10 years into the future. Significant developments or changes in economic performance, unhappily, cannot be reliably predicted more than 90 days in advance. However, large systems -- such as a national economy -- are enormously stable; they do not change their composition or direction radically over short periods of time. Thus, using historical trends, we can make relatively reliable projections about the basic nature of U.S. economic activity over the next 5 to 10 years.

To put these figures in today's perspective, we can pretty much know the composition of society between now and the year 2000. And, we can have reasonably accurate knowledge about the technologies that society will have at its disposal through 1995. Finally, while economic performance cannot be reliably forecast, the stability of our vast economic system does permit us to make some useful, valid assumptions about the most probable rates and directions of economic growth and change through 1990-1995. When combined, currently available demographic, economic and technologic projections make it possible to compile a coherent, detailed description of the principal features and dynamic inter-actions of the next 10 years. Such a description represents the "knowable future;" the most productive point of departure for any strategic assessment of the future.

Management surveys have shown that far and away the most common failure of planning is the use of erroneous basic assumptions about the future. Moreover, such research further indicates that the greatest achievements or improvements in organizational performance have generally not been due to any particular sophistication in planning, but merely from the avoidance of erroneous basic assumptions. By using the "knowable future" as a documented check list of most probable future realities, planners, policy makers and executives can reduce their chances of making erroneous core assumptions about their operating environment. More importantly, the knowable future provides the essential context for identifying strategically sound organizational commitments and investments.

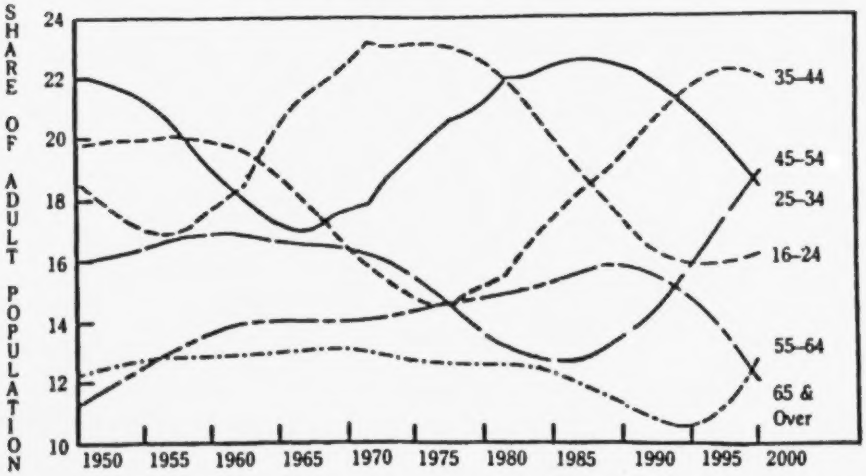
The essence of strategic management is to take actions that accommodate or exploit inevitable future developments over which an organization has no control. The following compilation of trends and developments reflect the strategic realities which will -- in large measure -- determine the imperatives and opportunities that will characterize the operating environment for public education during the next 10 years. As such, they are the knowable elements of education's near-term future which policy makers must plan to accommodate or exploit if they are to manage their way through the coming decade rather than merely muddle through.

Demography:
A Decade Of Dramatic Changes In America's Human Resource Base

In his classic book, The Wealth Of Nations, the great Scottish economist Adam Smith first asserted that a nation's principal resource is its people. Economic research since Smith's time has extensively validated this perception, and today, it is widely accepted that human resources are any nation's most valuable asset. As the formal institution charged with the principal responsibility for refining and developing America's human resources, public education must pay particular attention to the changing composition of that resource base. As has already been noted, the science of demography can provide educational planners with accurate, detailed information about the future make-up of society, from which crucial implications may be drawn regarding the future educational agenda. Graph 1, below, depicts the make-up of the U.S. adult population, broken down by 6 age groups, from 1950 to 2000. Three realities reflected in this data pose powerful imperatives for American education in the next 10 years.

GRAPH 1

AGE COMPOSITION OF THE ADULT POPULATION BY SIX AGE GROUPS



The "Baby Bust" Generation Comes Of Age -- Young adults (16-24 year olds), will decline as a share of the total U.S. adult population, from 23% in 1978 to 16% in 1995, reflecting the decline in U.S. birth rates from 1958 to 1975. As most educators are already well aware, this will produce an overall 1/4 drop in high school enrollments from 1976 through 1993. This will also entail a 1/4 shrinkage in the size of the entry-level labor pool, which is expected to drive up the wages paid to young, inexperience workers. To compensate for the short-fall in the labor supply, employers will be required to hire more women and minorities, reducing the long-term levels of unemployment and under-employment. By 1995, women are projected to make up 47%-48% of the U.S. workforce, (up from 44% in 1984), while minorities may be expected to rise as a share of the workforce from 10% in 1984 to 14%-15% by 1995.

While the foregoing developments will clearly represent significant progress toward increased social and economic equity in the U.S., they will also pose some substantial costs for American employers. From the early 1960's through the late 1970's, there was a surplus of entry-level workers in the U.S., as the Baby Boom generation poured into the adult population pool. As a consequence, entry-level wages were depressed, and employers were relatively free to hire and retain only the best qualified workers at relatively low salaries. But, as the entry-level labor pool steadily shrinks, more and more employers will be required to pay higher and higher wages for their new recruits. In addition, by the end of the 1980's, many employers will find themselves having to hire entry-level workers whose skills are so poor that they wouldn't have even considered recruiting them just 5 or 10 years earlier. Moreover, having been required to pay premium wages for marginal or sub-standard recruits, these employers will subsequently have to pay for the training necessary to provide these workers with the competencies necessary to do the jobs for which they have been hired.

These labor market realities will have significant implications for education. In the first place, there will be increasing pressure from the nation's employers to improve the quality of public schooling, or to provide a more effective mechanism for producing quality human resources. Any substantive effort to up-grade the quality of America's rank-and-file human resources will, of course, place greater demands on the nation's educational resources, whether in the public or private sector. Employers will also seek to reduce their needs for labor through increased automation, but mathematical models of the economy indicate that even the fullest application of available automating technology will not be sufficient to eliminate the effects of the short-fall in the entry-level workforce during the next decade.

Some portions of the U.S. business community are promoting an alternative solution to the impending shortage of human resources, patterned after European policies of the past 25 years -- e.g. the importation of "guest workers." While a guest worker program would not eliminate the necessity for remedial vocational training, it would drive down the basic costs for unskilled labor by eliminating the shortage of workers.Economists estimate that America would have to import between 10 and 20 million foreign workers during the next 10 years in order to offset the wage-inflating effects of the "Baby Bust" short-fall. Moreover, it should be noted that the European guest worker programs were necessitated by an absolute shortage of domestic human resources; during the 1960's and 1970's, unemployment rates in northern Europe were running between 1% to 3%. In the U.S., on the other hand, the importation of a large number of unskilled guest workers would merely duplicate a substantial domestic reserve of unskilled human resources. Under such a program, once the expenditures had been made to provide a sufficient number of new recruits with the necessary competencies for productive employment, America would still be left with a substantial residue of surplus, unemployable persons -- a permanent, non-productive under-class.

The "Baby Boom" Generation Matures -- At the same time that the young adult population will be shrinking, the number of middle-aged Americans (age 35 to 44) will be increasing by 50%, reflecting the maturing of the post-WW II Baby Boom generation. Throughout its history, the huge size of the post war Baby Boom has given it unusual power to alter the nation's market-place tastes and its political priorities. But, in the labor market, the size of the Baby Boom has worked to their disadvantage. As young adults, their large numbers created a surplus of new recruits that drove down entry-level wages and limited employment opportunities. And now, as growing members of this generation move into middle age, they will also be moving into mid-career, with associated expectations for upward mobility. But, because of the rapid increase in the numbers of candidates for a relatively limited number of promotional opportunities, millions of Baby Boomers will be faced with what the demographers call "mid-career compaction" due to "generational crowding."

During the 1970's, there were not many Americans aged 35 to 44, due to the "Birth Dearth" during the Great Depression. In 1975, there were an average of 10 candidates for every mid-career promotion opportunity in the U.S. But, by 1985, there will be 18 to 20 candidates for every mid-career vacancy, and by the mid-1990's, the ratio will be 30 to 1, or higher. Labor force analysts believe that, as upward mobility is increasingly curtailed, there will be rising worker frustration, alienation and stress, leading to reduced productivity and higher turnover. At least some of these employees will return to the entry-level labor pool in order to launch new careers. Many of these workers are already returning to school in order to learn new skills that will increase their promotability, or will permit them to shift careers to fields with greater potential for advancement. Thus, during the next 10 years, the inevitable force of generational crowding among the post-war Baby Boomers can be expected to produce significant increases in the demands for adult education, steadily transforming "life-span learning" from a policy concept to a practical reality.

The Baby Boom Echo Is Heard in the Land -- Since the full size of the post-war generation first became apparant, demographers have been forecasting that the principal legacy of the first Baby Boom would be another Baby Boom, called the "Baby Boom Echo." And, even though U.S. birth rates began to rise in 1977, the Census Bureau waited until 1982 to finally confirm the event, by forecasting that a new Baby Boom was about to occur. The new surge in births in expected to peak round 1990, at about 4 million per year, and ultimately produce about the same number of children during the next 10 years as did the first Baby Boom during the 1950's. It should be stressed that the rising numbers of births does not reflect a rise in fertility rates. In fact, average numbers of children per household have continued to fall steadily since the 1950's, in a trend that is common to all mature industrial nations. The Baby Boom Echo will simply be the result of the fact that 2/3 of all U.S. adults will be passing through their child bearing years during the next decade. Surveys of Americans of child-bearing age consistently show that 75% of them plan to have 1 or 2 children. Thus, the new baby boom will not reflect a return of large families, but merely the reality of tens of millions of couples producing 1 or 2 offspring apiece.

The rise in birth rates, combined with a simultaneous growth in the numbers of working women will, by definition, produce a significant increase in the numbers of working mothers. In fact, current forecasts indicate that, by the early 1990's, over 65% of all U.S. mothers will be gainfully employed, up from 40% in 1979, and an estimated 47% to 48% in 1984. These ratios would suggest that, by 1990, over half of the U.S. workforce will have at least one child at home under the age of 18 without parental care or supervision. This will include 9 to 10 million pre-schoolers, and 18 to 20 million school-age children ("latch-key" children). The projected vision of this rising tide of unattended children has provoked an ongoing public policy debate over the correct institutional solution to this growing social phenomenon. However, surveys of working parents clearly show that, rather than consign their offspring to institutional care, most would prefer that their employers institute new workplace arrangements, -- such as flex-time, job sharing and flex-place -- so that they can care for their children themselves.

These parental utilities are so strong that labor market analysts believe they will force rapid changes in workplace arrangements. At least 25% of the workforce is projected to be on flex-time by the early 1990's, up from 8.5% in 1981, and 13.5% in 1984. Another 28% are expected to be on part-time or job-sharing arrangements, up from 20% in 1984. And, researchers further estimate that as many as 5% to 8% of all salaried employees will be working out of their homes by 1990; 10% to 18% by 1995. While these innovative workplace arrangements will not eliminate the need for day care or after school programs, they can be expected to substantially reduce the requirements for such institutional social supports.

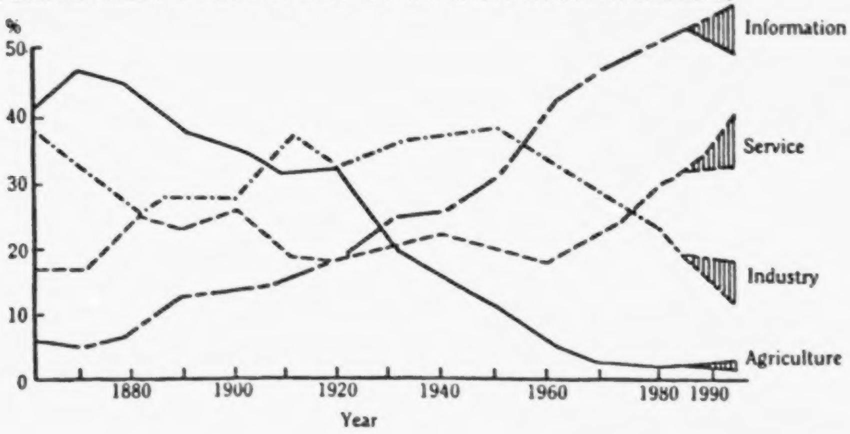
The Economy:
Ten Years of Trans-Industrial Turbulence

There is considerable uncertainty today about the future direction of the American economy. This is not without reason, since different indicators appear to reflect differing realities. While the industrial sector still produces the largest single share of our GNP (46%), the information sector employs most of the workers (51%), and the service sector is growing fastest both in employment and share of GNP. However, when all of these factors are pulled together, they reflect an orderly and logical process of transition, as the U.S. passes over the threshold of a new economic age. Simply put, America is currently about half-way through an economic transformation that is at least as substantial as the Industrial Revolution.

Of course, the United States came late into the industrial age, 50 to 75 years or so after the major European nations. Thus, the U.S. was able to copy much of its industrial engineering, infrastructure arrangements, and institutional initiatives (e.g. Social Security, workman's compensation, labor unions, unemployment insurance, etc.) from successful European models. In the current economic revolution, however, the U.S. is in the forefront! There are no successful models for us to imitate. Just as Britain and Germany had to invent the institutions and arrangements for the industrial age a century ago, the U.S. -- and Japan -- will have to create the basic institutions and arrangements of the information age, much of it during the next 10 years.

Graph 2

THE FOUR SECTORS OF THE U.S.
LABOR FORCE BY PERCENT 1860–1995
(USING MEDIAN ESTIMATES OF INFORMATION WORKERS)



Graph 2 shows the make up of the U.S. labor force, broken down by four major economic sectors, from 1860 through 1995. The shaded areas for 1985-95 reflect range estimates, depending upon different assumptions regarding automation, productivity and worker retraining. The dominant contemporary feature of Graph 2 is the pre-eminent position of information work, which has been the principal U.S. employer since 1956. Moreover, no reasonably anticipatable combination of future factors are expected to change this reality during the next 10 years; service work will remain the second largest employer, and industrial work will remain the third, with agriculture representing only a small minority.

The potential shifts in workforce mix during the next 10 years will arise largely due to various efforts to improve productivity. The pursuit of increased productivity will be the principal underlying economic force during the coming decade. This compelling need for increased productivity, in turn, will be driven by competitive pressure from the "Newly Industrialized Countries" (NIC's) of the 3rd World. After decades of developmental investments in infrastructure and education, nations like Korea, Brazil and Taiwan are able to produce a growing range of sophisticated goods with low-cost skilled labor (see Exhibit 1). Thus, in order to remain competitive, and to maintain their high standards of living, the mature industrial nations will have to achieve unprecedented increases in productivity over the next 5 to 10 years.

In the industrial sector, increases in productivity are variously projected to eliminate 4 million to 9 million jobs. In the information sector, the potential job losses from automation within the next decade are estimated between 5 and 10 million. Service sector employment, on the other hand, is expected to grow for two reasons. In the first place, the service sector has always functioned as the "employer of last resort" during periods of high job displacement; this is largely because service work, on the whole, requires fewer specialized skills than do the other sectors. Over the past 125 years, service work has risen and fallen as a percentage of the total labor force as technological innovations and marketplace changes have reduced employment in other sectors. But the current growth in service work will also be promoted by increased demands for services due to the rising numbers of 2-income households, which are projected to increase from just over 1/2 of all families today, to 2/3 of all households by 1990, and nearly 3/4 by 1995.

Thus, many people will shift into the service sector as a temporary expedient while they seek other employment, or while they return to school to acquire new skills that will improve their ability to find a more rewarding job. But, in addition to these temporary service workers, many displaced employees will remain in the service sector for the remainder of their careers, in response to the underlying long-term increase in the demand for services. These dynamics account for the substantial projected increase in service employment in what is widely presumed to be a "high-tech" economy. In fact, while there will be rapidly increasing demands for such jobs as computer systems analysts, programmers, and data processing mechanics, these increases are expected to generate only a few hundred thousand new positions over the next 10 years. By comparison, during this same period, service work will generate millions of new jobs, including over a million new jobs in the food services industry alone.

In summary, it is clear that a central concern of public policy during the coming decade will be the effective re-cycling of 15 to 20 million skilled blue collar, technical and professional employees who will lose their jobs due to improved productivity. This will include 2 to 3 million middle management personnel who will lose their jobs due to the "delayering of management" thoroughout major U.S. white collar organizations. This delayering, which began in the early 1980's, reflects a new U.S. management philosophy, fostered by such books as The Pursuit of Excellence, and modelled on the decentralized organizational structures of successful European and Japanese firms. The rapid adoption of these new structures has been made possible by new electronic management information systems, and made expedient by the "Great Recession" of 1979-83. From 1981 to 1983 over 1/2 of the "Fortune 1300" firms reported eliminating at least one entire layer of management nationwide. This "flattening" of the pyramidal profile of the traditional organizational chart will have the additional effect of further limiting the promotional opportunities of the Baby Boomers already blocked by mid-career compaction.

In conjunction with this transitional turmoil in the workplace, three other economic realities will be of particular relevence to education during the coming decade. One of these realities, in fact will be paramount.

Education Becomes America's Largest Industry -- As discussed above, a new Baby Boom, remedial education for sub-standard entry-level recruits, and the re-training of 15 to 20 million displaced and topped-out workers will all place major new demands upon American education. In addition to this, research by the National Science Foundation has determined that fully one-half of the costs of automation will be for the training of employees to work with their new electronic workplace technologies. When combined with the other growth requirements for learning, this suggests that, by 1990, the total annual expenditures for education will have grown by 20% to 25% from 1981 levels, and education will have surpassed medicine and health care to become the largest industry in America (see Exhibit 2).

Worldwide Capital Shortage Sustains Double-Digit Interest Rates Through the End of the Century -- In the pursuit of increased productivity, U.S. firms currently plan to spend an estimated $500 to $650 billion on automation. At the same time, increased national demands for education and training over the next 10 years are likely to cost between $500 and

$750 billion. These outlays, however, are relatively modest when compared to recent projections of U.S. infrastructure replacement requirements: e.g. $3.3 trillion for urban infrastructure replacement; $5.5 trillion for expanding, upgrading or replacing the residential housing stock; $1 trillion for repair of the transportation infra-structure. These huge demands, of course, merely represent U.S. capital requirements. The other mature industrial economies are also pursuing productivity-enhancing capital investments, will also have to retrain large numbers of their workers, and replace substantial amounts of their infrastructure. Moreover, the 3rd World nations will need to make investments of a similar scale simply to assure that their economies continue to grow rapidly enough to keep ahead of their rising domestic populations and expectations. The major U.S. economic models all forecast that, as a consequence of these enormous, combined investment requirements, there will be an ongoing worldwide capital shortage throughout the rest of the 20th century, with double-digit interest rates lasting through 2005, or beyond.

Such forecasts are accepted by many economists, most of whom believe that only a worldwide depression or a decade of unprecedented productivity gains will bring interest rates below 10%. Many business leaders share this view, and are concerned that high interest rates will sufficiently restrict capital investments that substantial sustained productivity improvements will not be achieved. If this were to happen, it is the conventional view that the mature industrial economies will slowly drift back into stagflation, dragging the rest of the world economy down with them. In this context, a key strategic consideration for all forms of enterprise during the next 10 years will be to achieve high increases in productivity with minimal capital expenditures. With public and political recognition of education's new importance will clearly generate some increases in public school funding, it is also clear that education will be constrained -- as will all institutions -- by the general shortage of capital. Thus, if it is to effectively meet its new responsibilities, public education will have to devote considerable attention to tangibly improving its own productivity.

Production and Population Disperse Throughout the Nation -- In a 1982 survey of high-tech firms, the Joint Economic Committee of the U.S. Congress (JEC) found that the most important criteria for selecting new plant sites is the availability of skilled, technical and professional workers. By comparison, fewer than half of the companies surveyed indicated that the availability of water or waste treatment facilities, or proximity to raw materials or markets were significant site selection criteria. On the basis of these findings, the JEC pronounced that high-tech industries are "footloose" enterprises that are free to site their operations wherever they have access to quality human resources, or where they can attract quality human resources. Moreover, since human resources are also relatively free to move wherever they wish, the potential for both industrial and population migration during the near-term future would appear to be high.

Of course, the mass movement of people and production to the Sun

Belt over the past 25 years is well understood, and it is expected to continue -- although at a diminished pace -- for at least the next 10 years. But the Census Bureau forecasts that the highest growth rates during the remainder of the 20th century will be in the Rocky Mountain states, where statewide population increases of 50% to 150% are expected. There is a third major migratory movement under way in the U.S., however, which poses more significant long-term implications for public education. This is the dispersion of both population and productive enterprises out of the center cities, and into "exurbia" -- i.e. those areas roughly 25 to 100 miles outside of existing urban hubs. Since the early 1970's, growing numbers of blue collar workers and their employers have been moving into exurban regions in pursuit of lower costs and greater "ambience." As a result of this migration, during the 1970's rural population grew faster than both urban and suburban populations for the first time in U.S.history (see Exhibit 3).

Cities are costly to live in and to operate in. As fewer enterprises require either the physical infrastructure or the huge pool of low-skilled workers that cities provide, there will be less and less reason not to relocate. At current migration rates, substantial portions of center city commercial and human resources bases will be eroded over the next 10 years. Until -- and unless -- center cities achieve some form of renewed economic utility, they will continue to deteriorate physically and socially. Within this environment, urban education will be faced with further limitations on its abilities and its potentialities. While public debate will focus on restoration and revitalization of cities, the underlying reality is that most large cities were necessary creations of pre-automated industrial production, and that, with the decline of labor-intensive enterprise, the need for many large cities will also decline.

Technology:
New Machines, New Arrangements, New Relationships and New Ways of Doing Practically Everything

"Technology" is the way we do things. More particularly, it is the way we arrange our resources and ourselves to get things done. There are two distinctively different types of technology. Tools, machines, chemicals or structures, etc., are regarded as physical -- or "hard" -- technologies, while organizations, institutions and laws, etc., may be thought of as social -- or "soft" technologies. Public education is one of the greatest modern social technologies. Both "hard" and "soft" technologies are powerful and essential tools of human progress and productivity. But they differ from one another in one crucial characteristic that is of great importance to all public policy makers.

Hard technologies are inherently durable, as their name suggests. As such, they change relatively slowly over time. Large physical technologies, such as factories, dams or school buildings, etc., typically have useful service lives of 50 to 100 years. Similarly, even when supported by a "national commitment," major breakthroughs or innovations involving hard technologies (e.g. fusion power, a manned moon landing, synfuels, etc.) generally take a long time; at least 10 years, and often much longer. On the other hand, soft technologies -- including very large and powerful ones, like social security or environmental protection laws -- can be implemented within one or two years. Similarly, large social technologies can be eliminated or radically altered quickly at will (e.g. the repeal of Prohibition, bank and airline deregulation, the current delayering of modern U.S. management, etc.). Because of this singular difference, it is possible to forecast future implementation rates for new hard techologies with some accuracy. While it is not possible to accurately forecast the development of new socal technologies. This is especially true for times of transitional change, when there are no historical models of appropriate social technologies.

Social technologies are creations of the moment and, as such, they offer policy makers and executives their principal opportunities to shape the future. Moreover, powerful new social technologies are often made possible by new physical technologies. For example, flex-place (salaried work in the home) is a new social technology that has been made possible by a new physical technology--the micro computer. Historical evidence, in fact, suggests that
the most substantial increases in productivity are typically achieved through such synergistic combinations of hard and soft technologies.

A Second Industrial Revolution -- The estimated $150 to $200 billion investment in industrial automation which U.S. manufacturers plan for this decade will represent the replacement of only 10% to 15% of the total fixed capital of U.S. industry. In short, the current surge of robots and computers into American mills and factories represents the initial stages of what will be a 30 to 40 year revolution in the structure and organization of manufacturing. At the completion of this revolution, most factories will be single, complex machines, each capable of producing a wide variety of goods; and the principal proprietary wealth of industrial firms will be the sophisticated software and data bases through which they will control the performance and output of their automated plants.

This first decade of the electronic industrial revolution will entail mostly incremental, single function applications of robots and CAD/CAM systems. Recent experience suggests that these applications can be expected to produce 30% to 50% improvements in the productivity of the specific operations where they are used, and generate an average 25% to 35% return on investment. Such benefits will be sufficient to fuel a steady growth in these kinds of applications. However, economic input/output analyses indicate that, even if all U.S. manufacturers were to exploit the fullest potential of such investments, the overall increase in U.S. industrial productivity would be insufficient to restore the general competitiveness of American goods in the world marketplace. For example, comparisons of the U.S. and Japanese auto industries have revealed that only 20% of the Japanese competitive advantage over American-built cars is due to the use of advanced hard technology, while 80% is due to better Japanese management, or soft technologies, including more productive workplace arrangements and relationships.

In particular, this "better management" includes the redesign of assembly lines to take advantage of the increased speed or capabilities offered by robot assemblers. It also involves rearranging logistical support systems to reduce the down-time of costly automated equipment. Workplace research shows that such redesign and rearrangements can increase the productivity afforded by new technologies by 100% to 400% or more. In short, in order to restore full competitiveness to the U.S. industrial sector, it will be necessary for American manufacturers to utilize both "hard" and "soft" technologies in their operations.

Information Workers Get Their First Taste of Automation -- While U.S. enterprise plans to spend $150 to $200 billion in industrial automation, twice that amount ($300-$400 billion) is currently budgeted for automating information work. To a large degree, this is due to the fact that the average U.S. industrial worker is already supported by approximately $30,000 worth of productivity-enhancing capital investments, while the average information worker is supported by only $2,500 worth of capital goods. By 1990, the per capita capital investment for each blue collar worker is projected to rise to $40,000 (an increase of 35%), while white collar capitalization in expected to reach $10,000 per employee (an increase of 400%).

As with industrial automation, integrated rearrangements of office operations made possible by new information technologies generate considerably greater increases in productivity than do incremental applications in which typewriters are merely replaced with word-processors. This same principal applies to the use of productivity-enhancing electronic technologies in education. For example, classroom experiments have shown that a network of micro-computers is four times more cost effective than a central computer with remote terminals, and five times more cost-effective than a similar number of free-standing micro-computers, in terms of the amount of meaningful student use-time provided per dollar spent. Given the combined realities of rising demands for education and a sustained capital shortage, educators can ill afford to make sub-optimal capital investments. Thus careful consideration should be given to more productive rearrangements of all aspects of educational delivery made possible by new technologies.

Collaborative Workplace Relationships: The Most Productive Social Technology -- A substantial body of rigorous scholarly research strongly indicates that the principal productivity advantage that many Japanese and European firms enjoy over their U.S. competitors is the collaborative working relationship that exists between management and labor. More precisely, American producers commonly suffer poorer productivity than their foreign competitors largely because of the traditionally adversarial relationship between U.S. management and labor, which inspires little worker loyalty or commitment, and which fails to tap the valuable information and experience of rank-and-file employees. Not only does management fail to utilize this potentially valuable information resource, but employees who are unable to make meaningful personal contributions to their work are inclined to direct their emotional commitments and intellectual energies to other, more rewarding activities than their jobs.

The quintessential form of workplace collaboration is Edward Deming's "Worker Design System," which the Japanese later renamed "Quality Circles." Basically, Quality Circles involve a formal mobilization of rank-and-file employees to channel their experienced-based knowledge and insights into managerial decision-making processes in a timely and useful manner. Such inputs have repeatedly been shown to substantially improve product quality and reduce operating costs. Moreover, by giving rank-and-file personnel the opportunity to make substantive contributions to their work, these new arrangements also serve to increase job satisfaction, with commensurate rises in employee commitment and loyalty, and significant declines in absenteeism, turnover, and grievences. Thus collaborative workplace relationships promote increased productivity both by improving the quality of output and by improving human resource utilization.

An ample array of real-world workplace experiments have made it clear that Quality Circles are powerfully effective, so long as they are implemented with integrity. They have been used not only on the factory floor but in the office, on police forces and in schools. Quality Circles have proven effective in redesigning office layouts, redrafting government procedures, and developing new curricula. They have the advantages of other social technologies, in that they can be quickly implemented at low cost. Their only draw-back is that they require employees and managers to abandon their traditional adversarial attitudes toward one another. Unfortunately, this is apparently so difficult a task that only about 1/3 of U.S. organizations that have experimented with Quality Circles report them to be truly effective.

The Electronic Info-Structure and the Information Consuming Society: A Great Confluence of Change -- Both market surveys and expert forecasts commonly agree that by 1990, 50% of all U.S. households will own their own computers; by 1995, this is expected to be 60% to 65%. This portion of society roughly corresponds to the percentage of the adult population who actively seek information from outside their closest circle of collegues, friends and relations in order to help them make better decisions. These people represent the information consuming share of our society. These are the people who have made self-help books the largest selling category of books in the U.S.for over a decade. These are the people who have made the all news radio and television formats the fastest growing segment of the broadcast media during the past decade. They include some 85 million Americans who, according to the U.S. Surgeon General, have modified their lifestyles sufficiently over the past 20 years to account for a 45% drop in heart attacks and a 6 year increase in the average life expectancy.

As the information-consuming 2/3 of our society acquire computers, they will constitute a ready market for an enormous array of information products and services, including data base systems offering performance ratings and evaluations on a variety consumer of products and services. Other consumer information services will include: health promotion and diagnostic software, self-help networks, electronic mail, real time stock reports, computerized dictionaries and encyclopedia, financial accounting and tax computation systems, plus a broad mix of learning sources, ranging from educational software packages to nationwide university teaching networks.

There are three secondary realities, implicit in the foregoing projections, which are of strategic importance to education. In the first place, it is reasonable to assume that, given current market penetration rates, the vast majority of all teachers and school administrators will have their own computers within less than 10 years. In the second place, as a growing share of the total population acquire their own computers, they will incidentally be equipping themselves with access to several alternatives to traditional sources of education. (Within less than five years, the sales of educational software is projected to exceed all text book sales, and 3/4 of that software is expected to be purchsed by households, while only 1/4 will be purchased by educational institutions.)

And finally, while 2/3 of the nation's households are expected to be active computer-users by 1995, the remaining one third of all Americans, who are already largely non-information consumers, will fall further and further behind the rest of society as they remain cut off from the powerful tangible benefits that will be available to those who are "computer competent." By the end of the next 10 years, these information-have-nots will begin to exhibit significant disfunctions, including poorer health, higher mortality rates, lower income, etc.

PART II

HUMAN CAPITAL, ECONOMIC DEVELOPMENT AND PUBLIC EDUCATION IN THE DECADE AHEAD

At the outset of Part I of this paper, it was observed that human resources are a nation's principal economic asset. In the U.S., this general rule may be demonstrated by a number of measures. For example, for most enterprises, wages and employee benefits typically account for 65% to 85% of operating budgets, while all other expenditures -- e.g. capital investments, taxes, rents, raw materials, interest, etc. -- typically account for 15% to 35% of total budgets. Moreover, economic analyses indicate that human resources create an estimated 85% of the value added by all productive processes, while materials and facilities are the source of only 15% of the value added by commercial production.

In light of the predominant economic importance of human resources, it is not surprising that economists almost uniformly agree that the current workplace transition will require substantial changes in the skill base of the nation's human resources. A growing number of business and political leaders echo the sentiments of Harvard economist Lester Thurow, that "it is not possible to build a high-tech economy with low-tech components," and that the most important component of our economy -- the workforce -- must therefore be upgraded. The Joint Economic Committee survey cited in the Economics portion of this paper makes the linkage between quality human resources and future economic growth patently clear, by revealing that the availability of quality technical and professional personnel, and of skilled rank-and-file workers, are far-and-away the most important criteria for the selection of new plant site locations by high-tech industries (see Exhibit 4).

The educational implications of these fundamental realities have not been lost on the nation's policy-makers. A 1984 survey by the Congressional Office of Technology Assessment (OTA) found that 10 of the 22 most common state and local government initiatives for attracting high-tech businesses involve new educational programs (see Exhibit 5). Within the past five years, over 3/4 of the states have sponsored major studies or commissions aimed at improving the quality of public education. At the same time, the issue of worker retraining has begun to emerge as one of the nation's principal domestic political concerns, and as a central focus of both labor negotiations and economic development proposals.

Pursuing Economic Development Through Educational Excellence -- State initiatives to improve the quality of public education have been shaped by two key sets of inputs. The first has been a rising tide of complaints from the business community and the nation's colleges and universities over the deteriorating abilities of high school graduates. These complaints have been bolstered by declining test scores, and legitimized by several national studies. Numerous surveys of employers indicate that as many as one-half of new employees consistently lack basic skills, such as spelling, grammar and the ability to compute simple arithmetic problems. In a related dimension of the problem, studies of adult education needs consistently show that 20% to 30% of U.S. adults are not "functionally competent" enough to manage their own lives effectively and efficiently.

The second set of inputs shaping current educational reforms has been the desire to attract high-tech industry by producing increased supplies of high quality human resources. Characteristically, the public policy initiatives produced in response to these two sets of concerns have included proposals for: 1) increased length of school day and/or school year; 2) reduced student/teacher ratios; 3) more stringent student testing and promotion processes; 4) improved teacher competence through more rigorous certification requirements, performance evaluations and/or incentive pay 5) expanded mandatory curriculum for college-bound high school students; 6) computer aided instruction (CAI) and "computer literacy."

Salvaging the Casualties of Workplace Automation and Global Competition -- The current consensus regarding the necessity to upgrade public schooling has emerged over a number of years, in consonance with the long-term decline in national test scores. Concern over the need for a national worker retraining policy, on the other hand, has evolved only recently, in a relatively short time, in response to the widening understanding of the truly revolutionary scale of the current techno-economic transition. Today, however, while there is a growing agreement that millions of displaced workers will have to be "re-skilled" during the coming decade, there is considerable disagreement over how this task may be best accomplished. The current debate over a national worker retraining policy may be broadly defined as reflecting two alternative approaches to the task: 1) institutionally-based programs; and 2) marketplace-based programs. The former would make specific institutions responsible for the bulk of worker retraining. Such proposals cover a wide range of options, including a) in-house, employer run programs; b) government programs similar to the old CETA operation; and c) consortia programs, such as those sponsored by local Private Industry Councils (PIC's) under the present Jobs Partnership Training Act, or similar programs designed and conducted jointly by employers and unions.

Marketplace-based retraining policies, on the other hand, would neither create new training institutions, nor place the responsibility for worker re-skilling on specific existing institutions. Such proposals concentrate, instead, on providing financial support to individuals to help them meet the costs of their retraining. Like the institutionally-based policies currently being advanced, market-based approaches to worker retraining cover a number of options, including: a) tax deductions for all adult vocational education; b) tax exempt "Individual Training Accounts" (ITA's), like IRA's, into which both employers and employees may make payments to accumulate funds to pay for a worker's future retraining; c) voucher systems to subsidize the training cost of displaced workers who cannot find employment; and d) a new "G.I. Bill." The fundamental assumption behind these proposals is that if displaced workers have the funds to pay for their retraining, the educational industry -- including both private and public sector institutions -- will develop vocational programs that will accurately respond to labor-market demands.

Problematical Aspects of Current Policy Proposals

The foregoing array of public policy proposals all represent earnest attempts to mobilize America's second largest industry to deal with a number of critical and compelling national needs. Any action that would substantially alter or expand so large an institution as public education must, by definition, pose powerful implications for the nation as a whole. Thus, before any such policy proposals are assessed in terms of their educational consequences, they should first be examined from the standpoint or their national implications. From this perspective, of the principal current policy initiatives and proposals for post-industrial curriculum reform and for trans-industrial retraining all share two common, fundamental uncertainties: 1) resource availability; and 2) socio-economic utility.

PROBLEM NUMBER ONE
Cost-Effective Educational Expansion and Reform

In Part I of this report, it was asserted that education would become America's largest industry by the early 1990's. This projection was based upon a compilation of forecasts relating to probable student populations for K-12, post-secondary, vocational-technical, employee and continuing education programs. The estimated costs for schooling these populations were based upon current ranges of actual per-student costs. Thus, these projected rises in educational expenditures -- which would represent a 20% to 25% increase over current outlays --do not take into account any major future changes in current educational delivery systems or operating arrangements. If the most commonly adopted current proposals for educational reform were to be adopted nationwide, the annual expenditures for public education would have to be increased by an additional 20% to 25%, over and above the increases required by the general growth in demand.

As was previously discussed, a number of economic projections indicate that a worldwide capital shortage will sustain double-digit interest rates beyond the year 2000. While the compelling necessity to upgrade our productive human resources will clearly elicit significant increases in both public and private sector funding for education and training during the coming decade, there will also be equally compelling demands upon the limited supplies of discretionary capital for equally essential national purposes, such as productivity improvement, infrastructure replacement, high-tech R&D, and new businesss ventures. Thus, it cannot be casually assumed that the imperatives of educational excellence and worker retraining are so great that there will be financial resources available to pay for all of the policies and programs that could -- or should -- be instituted in pursuit of these two goals. In fact, current projections indicate that, absent unprecedented increases in national productivity, there are likely to be insufficient resources available to meet all of the critical educational requirements of the next 10 years.

This basic reality would strongely suggest that all proposals for both post-industrial educational reform and for trans-industrial retraining should be rigorously assessed in terms of their proven cost-effectiveness, in order to assure the adoption of the most productive initiatives. This fundamental criterion is equally applicable to the employee training activities of individual organizations, the commitments and investments of local school systems, state educational policies and Federal retraining programs.

Resource Realities and Effective Educational Reform for Trans-Industrial America -- There is an extensive body of research covering the productive factors in education (A major survey of that literature is summarized in Exhibit 6). These data indicate that there are three methodological initiatives which are unusually effective in increasing the productivity of formal education. These are: 1) structured, modularized instructional materials; 2) project assignments, involving peer teaching or tutoring within work teams; and 3) "precision " teaching. (See Exhibit 6 for more detailed descriptions.) Significantly, the research shows that each of these 3 methodologies has three to four times greater potential for increasing educational effectiveness than do such currently common reform initiatives such as increased class time or improved student-teacher ratios.

Meanwhile the potential impact of current proposals to improve teacher "quality" must be regarded as problematical on several counts, inasmuch as there are no rigorous, proven criteria or standardized measures of teacher quality. However, a recent study by the Educational Testing Service (ETS), (see Exhibit 7), indicates that the incidence of superior educational performance among colleges and universities is not highly correlated with such traditional measures of excellence as highly selective student screening or numbers of Ph.D's. In fact, the ETS survey showed that "project work," involving real-world applications of rote classroom learning, was the one factor common to all superior educational performance at the post-secondary level.

Similarly, studies conducted by employers and labor force experts consistently show that student involvement in assignments requiring real-world applications of classroom knowledge substantially increase the level of educational achievement for both secondary and post-secondary schooling. This factor is generally not reflected in the most common current proposals for improving educational excellence.

But, such arrangements -- in the form of "student internships" and co-operative work-study programs -- are rapidly being established throughout the U.S. between employers and public schools, community colleges, vocational-technical training programs and 4-year post-secondary institutions at the local level. The 1984 OTA survey (cited earlier), found that work-study programs are one of the 22 most common initiatives being adopted by local jurisdictions as a means of encouraging high-tech economic development.

The two other highly-productive educational methodologies cited above -- i.e. structured systems of instructional materials and precision teaching -- are simply not included in any of the current initiatives for educational reform. The use of computers, on the other hand, is increasingly perceived as a key element of high-tech education. Research into educational productivity, however, indicates that the tangible benefits from computer aided instruction (CAI) have been limited, especially at the secondary and collegiate levels. CAI has proven to be twice as productive in elementary school applications, where computers are particularly effective in facilitating rote learning, for which a considerable body of software has been developed.

Improved cost-effectiveness of CAI for secondary and higher education would appear to be dependent upon the development of more sopohisticated computer-based instructional materials. In fact, the structured, modular curricula which have proven to be so highly productive in research findings are also ideally suited for direct transfer to computer delivery. Moreover, once a modular set of instructional materials has been computerized, precision teaching -- which is exhorbitantly expensive otherwise -- can be instituted with relatively little cost. In summary, by adapting both curriculum and student evaluation processes to the unique capabilities of computers, the ecucational productivity of computers can be increased several hundred percent. This is a characteristic example of the general principle described in the introductory discussion on Technology (see page 12), in which the integrated utilization of new technology is typically 100% to 400% more productive than incremental utilization.

The Technology section of Part I concluded with a brief discussion of collaborative employer-employee relationships (e.g. "Quality Circles," team work, etc.). In that discussion, it was observed that when instituted with integrity, such formalized systems of worker involvement are enormously productive for all forms of enterprise, including education. Further, such collaborative arrangements have been particularly effective in facilitating the optimal assimilation of new technologies, programs and procedures. In view of the fact that public education will be confronted with massive imperatives for productivity improvement, technological innovation and institutional adaptation during the coming decade, educators on both sides of the labor-management relationship should regard collaborative workplace arrangements as their single most powerful potential contribution to the future of their profession, and their continued ability to serve the nation.

Resource Realities and Effective Worker Retraining In a Decade of Techno-Economic Revolution -- The national imperative for worker retraining will be faced with the same resource constraints as public education, and thus, the same incentives for maximum cost-effectiveness. Research in vocational education shows that in-house retraining of displaced employees to fill other jobs with the same employer is far-and-away the most effective and cost-efficient human resource re-cycling process. It is superior to all other re-cycling processes that require displaced workers to change both employers and career fields for two reasons. In the first place, in-house programs are consistently most accurate in targeting retrained workers for specific available jobs. In the second place, in-house career shifts permit workers to build upon their previous experience-based workplace knowledge, in spite of a change in career fields. This knowledge sustains the retrained employee's productivity in his or her new job, and further sustains his or her long-term earning capacity. This latter factor is particularly important for workers who must change careers after ten years on the job. Labor market statistics show that employees who shift career fields and employers after ten years in a prior field are likely to experience a significant reduction in their life-time earning potential.

A second key factor influencing the effectiveness of worker retraining is revealed by research on the management of innovation and change. These studies show that voluntary programs are consistently much more successful and more cost-effective than mandatory or circumstantial programs. This applies to all employee development and retraining programs. Many major employers in both the public and private sectors have long been aware of the singular importance of voluntary commitment to the success of any effort aimed at changing employee behavior or performance, and have routinely used this criterion in the design of their human resource development policies and programs. At the same time, the voluntary factor is often completely overlooked in the development of employee training plans, and is seldom if ever used in evaluating public policy options. In light of the extremely poor track record of non-voluntary employee change programs, the criteria for assessing alternative worker retraining policies and programs should include the degree to which various individual options are likely to elicit voluntary commitments on the part of displaced, or soon-to-be-displaced workers.

To the extent that employer-members of PIC's and other consortia are able to accurately forecast their collective future personnel needs and effectively translate these needs into specific curricula offerings, such local collaborations reflect one of the key advantages of in-house retraining -- i.e. the accurate linkage of specific training programs to specific labor market needs. Historically, retraining programs without such direct linkages to employers have been relatively poor at correctly reflecting actual labor market demands, in part because such programs have also been responsive, to one degree or another, to the desires and expectations of the retrainees. These desires -- social and economic utilities -- logically lead individuals to pursue re-skilling in fields that offer them high wages and/or high status, or in fields that are only incrementally different from their previous work. Such decision criteria unavoidably lead to mis-matches between the mix of re-skilled workers and actual labor-market demands, and reflect a waste of both capital and human resources invested in the acquisition of un-needed skills.

It is commonly argued that marketplace-based retraining programs are superior to institutionally-based retraining programs. However, so long as the providers of retraining ultimately depend upon the use of their services for their own livelihood, the curricula they offer are likely to be determined more by the demands of the trainees than by the requirements of the labor market. And, so long as trainee desires and expectations do not match employer requirements, marketplace-based worker retraining programs are likely to be less effective, and less cost-efficient, in general, than institutionally-based retraining in which the content and mix of curricula is directly linked to specific employer requirements.

In summary, the most productive mode of employee retraining is voluntarily undertaken, should build upon the trainee's prior experience, and be targeted to a specific, available job. Some large employers, like Ford, have already instituted such programs, and other big, diversified enterprises are likely to do so. But most employers do not have internal job markets sufficient to re-absorb more than a small fraction of employees made redundant by automation or overseas production. Under present assumptions, therefore, most displaced workers are likely to enter retraining programs with less than voluntary commitment, and receive instruction which neither builds on their prior experience nor prepares them for a specific job. For many of these retrainees, this career transition will result in a permanent, substantial reduction in their life-time productivity and earnings. Taken together, these collective losses of income and output will represent the costs to society and the economy of worker retraining strategies that have been more expedient than they have been productive.

PROBLEM NUMBER TWO:

Socially Progressive Curricula for Post-Industrial America

At least one over-arching conclusion should be drawn from the preceding discussion of cost-effectiveness: both the conventional wisdom of current educational reform and the conventional assumptions of current workforce planning are promoting national and local policies and strategies which scholarly research and best real-world practice show to be economically sub-optimal. The following discussion of post-industrial curricula further suggests that these same forces are promoting strategies and policies that are socially sub-optimal as well.

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Socio-Economic Utility and Post-Industrial Curricula

Any curriculum is, by definition, a forecast of the future. When designing a particular course of study, curriculum developers are making tacit assumptions about the skills and knowledges that a student will need to possess in the future. In this light, current debates over educational reform raise some serious questions about the economic and social future of the U.S. In the first place, it should be noted that most of the current proposals for educational reform are not directed at altering present curricula, but at improving the effectiveness with which the present curricula are taught. The only significant curriculum changes being sought in education are intended to improve the rigor of the schooling received by college-bound students. These measures have chiefly been aimed at reducing the number of remedial courses that colleges and universities are required to conduct, and at demonstrating a tangible commitment to attract high-tech enterprise.

Such "high track-high tech" educational policies have drawn criticism from some educators who point out that most labor market forecasts show that 15% to 25% of the new job openings created during the next decade will require a baccalaureate degree, while 50% to 75% are projected to require some form of post-secondary technical training. And, while public schools, community colleges and proprietary training institutions debate (and lobby), over who is best qualified to provide students with such technical skills, rank-and-file employers complain that half or more of current high school graduates do not even possess such essential basic competencies as spelling, grammer and arithmetic.

In the midst of this national dialogue over immediate solutions to near-term problems, observers who examine long-term workforce trends have begun to raise some worrisome questions about the future of American society, and public education's role in that future. Specifically, while current forecasts of growth in high-tech industries are commonly expected to produce increasing job opportunities for skilled technical and professional personnel, current forecasts of employee displacement due to automation and foreign production indicate that from 3 to 10 times as many skilled, technical and professional jobs will be eliminated as will be created! As this net decline in the number of high value jobs progresses through the decade, a growing share of all employment will be in low value, low pay service and clerical positions.

As was previously cited in the discussion of "quality circles," several studies indicate that many (perhaps most) American workers have had more formal schooling than is actually required for their jobs. Department of Labor statistics (see Exhibit 8), and a number of workforce analyses show that there is already a surplus of college graduates in all but a very few disciplines, and that for several major professions, (engineering, medicine, law, etc.) real income per capita has been falling for up to a decade, or more. This apparent "over-skilling" in the workforce has, in turn, been linked by some studies to declining job satisfaction and lowered productivity. Thus, confronted by high-tech reforms and employer complaints that high school and college graduates cannot spell, educators are now also being presented with some compelling evidence that a growing number of American workers are "bored" by their jobs. These new perceptions have not been lost upon educators. In surveys conducted by the author of this report, teachers and school administrators picked "teaching people how to lead self-fulfilling lives in non-fulfilling careers," as a goal for post-industrial education almost as often as they picked "computer literacy."

This confluence of apparently paradoxical requirements upon education was anticipated and explained over a decade ago by Harvard sociologist Daniel Bell in his classic book, The Coming of Post Industrial Society. Extrapolating from precursor trends of the 1960's, Bell detailed the emerging social consequences of the underlying techno-economic changes that were already at work in America. Basically, Bell's analysis indicated the impending rise of a professional-technical elite, amounting to only 1% to 5% of the total workforce. These people would represent the only high-value jobs and truly meaningful roles in society. All other employment would involve low-level, low-paying routine tasks.

Significantly, Bell's post-industrial scenario also assumed that the long-term rise in general levels of sophistication and competency throughout the population would continue due to the ongoing influences of mass education and mass communications. A natural consequece of the two simultaneous trends -- i.e. a decline in meaningful work and a rise in general levels of sophistication -- Bell correctly anticipated, would unavoidably lead to dissatisfaction and disaffection in the workplace, and the increasing pursuit of self-fulfillment outside the workplace.

Professor Bell was not happy with his scenaric; nor did he believe it was inevitable. But he did feel that it represented the most likely future for the United States, and one which could be avoided only by diligent care and intelligent policy intervention. A growing number of social scientists share Bell's perceptions and concerns, as do many economists, who document a widening gap between poverty and prosperity in this country, and an accelerating concentration of earning power in the U.S. over the past 10 years. The social implications of current economic trends, if they continue as presently projected, will be devastating: a steady diminution of the middle class, to be replaced by a high-tech/low-tech socio-economic caste system.

It should be noted with considerable concern that the principal educational reforms currently being adapted throughout this country are disturbingly in consonance with Daniel Bell's scenario. While the academic requirements for college-bound high schoolers are being made more stringent (and restrictive), the only significant curriculum upgrading proposed for all other students is "computer literacy." Such an educational strategy, if broadly instituted, can reasonably be expected to produce a significantly reduced supply of professional and technical personnel, while longer hours of study in "reading, writing and 'rithmatic," augmented by exposure to computers, will adequately prepare non-collegiate students for careers as low-levels functionaries in the service and information sectors. Given such a scenario, the notion of "teaching high schoolers how to lead self-fulfilling lives in spite of non-fulfilling careers" would be frightenly appropriate.

While a number of social scientists, economists and educators express serious concerns over the relatively obvious social implications of current educational policy initiatives, the fact remains that the immediate logic supporting these initiatives is compelling. However, as was observed on page 1 of this report, the most common errors of planning are not in the logic of the planning model, *but in the core assumptions* to which that logic is applied. The principal erroneous assumption inherent to most current educational reform initiatives is that our near-term future will be our long-term future!

Throughout this document, it has been repeatedly asserted that America is at the beginning of a techno-economic revolution that will take 30 to 40 years to complete. In this context, the rapid growth of service sector employment is a natural and *temporary* consequence of transitional job displacement, and not necessarily a permanent shift in the work force mix. Within the next 5 to 7 years, as currently planned, massive investments in the electronic infrastructure create new markets for information products and sophisticated commercial services, the numbers of higher value technical and professional jobs created can also be expected to grow exponentially, drawing down the human resource reservoir of transitory service workers.

Such a scenario would be typical of historical patterns of national development during similar periods of techno-economic transition in the past. Clearly, a key concern of public education under such a scenario would be a description of the specific high growth, high value jobs that will begin to appear in large numbers by the end of the 1980's. Unfortunately, the remarkably "fertile" potential for innovation posed by the interaction between new technologies and new economic utilities during the next 5 to 10 years makes it impossible to accurately forecast the precise nature and number of new workplace roles that will be created. We cannot reliably project the demand for "laser technicians," for example, until we can reliably forecast the number of lasers that will be in use, *and* how much service they will require. And, we cannot reliably forecast the numbers of lasers that will be sold until we can accurately estimate the numbers of productive uses to which lasers will be put, and what their cost-effectiveness will be for each such use. Etc. Etc.

This same sort of litany may be recited for each of hundreds of potential new career opportunities that are likely to emerge as the electronic revolution matures. This circumstance would appear to leave educators with no better insight on the appropriate post-industrial curricula than that provided by the current extrapolative forecasts of a near-term workplace dominated by low skill, low pay service and clerical work. In fact, the very transitional nature of the next 10 years implicitly dictates the principal imperative for post-industrial curriculum. If the purpose of education is to prepare the student for the future, then public education today should be preparing the student for change. Specifically, K-12 education should provide students with skills and knowledges they will need to pursue successful "sequential careers" and to fully utilize the benefits offered by "life-span learning."

Such a charter would suggest that schools should impart a rather broad array of general purpose skills. Exhibit 9 presents two lists of such generic or transferable skills that were developed by major government research projects in Canada and the United States. The Canadian list, in particular, will seem quite familiar to most American educators, reflecting as it does much of the typical content of standard K-12 curricula. In both lists of general skills, the elements that are least familiar as formal curriculum content are the reasoning and inter-personal skills. These represent process skills or learned behavior rather than rote knowledge. It is, in fact, these process skills that American employers most often report that they find lacking in recent U.S. graduates. Further, a general weakness in process skills limits an individual's ability to apply his or her rote knowledge. This could explain at least some of the disparity between the relatively high student test scores reported by schools and the relatively poor graduate performance ratings reported by employers.

Most important of all, it is these process skills that will be most essential for young Americans to effectively deal with lives and careers that will be filled with the problems and opportunities posed by continuous change. In spite of the failure of current educational reforms to address the general K-12 curriculum content, recent trends in educational innovation indicate that a growing number of schools and school systems are undertaking strategically sound initiatives that will serve to increase the affective and process skills of their students.

Prominent among the more effective public school innovations are the internship or "work-study" programs that were discussed earlier in this paper, in the section on educational productivity. These collaborative employer-educator arrangements not only increase the overall rate of learning, but are particularly effective as a means of learning both inter-personal and problem-solving skills. As a complement to this trend, a limited number of public schools have begun to experiment with classroom teaching of reasoning skills.

The recent rapid influx of computers into public schools offers an enormous potential for teaching reasoning and problem-solving skills, Moreover, when computers are linked into networks, they have been shown to offer unique new opportunities for experiencing and learning inter-personal skills. Educational channels of local cable television systems also offer a rich array of opportunities for learning affective and process skills, especially where students operate studio facilities and produce program material for broadcast.

To some degree, in fact, the general failure of current educational reforms to stipulate specific K-12 curriculum content can be regarded as a blessing. As a consequence, educators are being left relatively free to pursue a wide variety of innovations. As the more effective of these innovations become apparent, their general dissemination throughout public schools during the next three to five years should begin to produce significant improvements in overall student performance, and in graduate acquisition of the generic skills that will prepare them for a life of change. Meanwhile, as with the innovations now being introduced in the nation's factories and offices, the successful educational innovations of the next five years will merely represent the beginning of a long-term process, during which the integration of modular curricula, electronic teaching, workplace learning and home computers will completely revolutionize public education in America.

Once again, the rich potential for educational innovation during the coming decade makes it impossible to accurately predict the ultimate form of post-industrial public education. However, it is clear that the exploitation of change and innovation will be the principal challenge to educational leaders during the next ten years. And, how they respond to that challenge will largely determine the shape of public education for the next half century or more.

Socio-Economic Utility and Worker Retraining

Just as with the general post-industrial curriculum, the most problematical social and economic implications of worker retraining are raised by the near-term forecasts of changing workforce mix. During the coming decade, while an estimated 2/3 to 3/4 of the jobs to be eliminated may not be classified as skilled, technical or professional positions, only 1/6 to 1/4 of the jobs to be created are expected to represent such skill levels, or to pay such hugh salaries. Thus, the bulk of worker retraining programs -- if accurately targetted to meet currently projected workplace demands -- will actually represent a massive de -skilling of human resources rather than a re -skilling. The term "de-skilling," in this context, is not merely a figure of speech. The economic costs of shifting milliions of workers from high value to low value jobs will extend well beyond the simple loss of income to individual employees.

In the previous discussion of cost-effective worker retraining, it was observed that when an employee changes career fields after having been in one field for more than ten years, he or she routinely experiences a significant reduction in life-time earnings. This is true even where an individual shifts between two career fields with essentially equivalent pay scales. The principal reason for this decline in earnings is reduced productivity caused by the devaluation of the employee's "intellectual capital" -- i.e. the accumulated knowledge, skills and insights that the worker has gained through experience and formal training in his or her previous career. Research in labor market economics indicates that, on the average, up to 50% of life-time earnings gained and over 50% of individual productive capacity are derived from intellectual capital. But, most of the knowledge and skills learned through work experience is derived from a specific career field and a specific employing organization, only a small portion of the productive value of the average worker's intellectual capital is transferable to a new career with a different employer.

In a very real sense, an individual's intellectual capital is the product of the combined investments in time and money (wages), training and on-the-job learning, made by both employee and employer over the years. These investments in turn, are the principal source of an individual's productive capacity. But, when an employee changes careers in mid-life, the potential return on these investments is significantly reduced. Thus, if current projections of job displacement and workforce transition are actually born out, not only will millions of U.S. workers be forced to move to less productive, lower paying jobs, but they -- and the nation as a whole -- will also suffer substantial losses in the future returns from their extensive prior investments in intellectual capital. Moreover, as was cited in the previous discussion on post-industrial curriculum, over-skilling in the U.S. workforce has already been linked to declining job satisfaction and lowered productivity. As millions of employees are moved from high skill to low skill jobs, overall levels of job satisfaction can be expected to decline, creating a further pressure for reducing the productivity of re-cycled workers.

In light of the compelling need to increase national productivity, a national commitment to systematically reduce the productive capacity of 10 to 15 million skilled and professional workers whould seem questionable at best. Indeed, a broad range of economists and educators have raised serious questions about both the wisdom and the viability of worker retraining as it is currently envisioned. (As a Vice-President of Pittsburg's Mellon Bank stated recently, "I find it hard to believe that very many $26.50/hour steel workers are going to volunteer for retraining as $6.00/hour data entry procesors.") In spite of the significant economic and social disfunctions involved, however, conventional policy perceptions across the entire American political spectrum currently accept the idea that some form of worker retraining program will be an essential concommitant to the nation's post-industrial transition.

The central assumption which validates these policy perceptions is that the most effective means of increasing national productivity is through the replacement of labor by capital-intensive technlogy. But, as observed in the Part I discussions of eonomics and technology, currently-planned investments in physical technology will not, by themselves, increase U.S. productivity sufficiently to restore the American economy to general levels of global competitiveness. More importantly, research into productivity reveals that the workforce, not physical technology, is the principal source of increased economic productivity. For example, one study, from MIT's Sloan School of Management, indicates that, in the U.S., about 70% of all measurable improvements in productivity during this century have been due to a continuous process of suggestions and modifications made by workers, supervisors and managers, while less than 30% of all productivity improvements have been due to major capital acquisitions.

Exhibit 10 contains extended exerpts from 1981 Congressional Hearings titled, "The Human Factor in Productivity Improvement and Technological Innovation." These Hearings assembled testimony from major corporate presidents, labor leaders, and workforce experts, each of whom presented rigorous evidence attesting to the unparallelled capacity of skiled, experienced workers both to increase productivity and to most effectively assimilate and exploit new workplace technologies. In particular, the testimony gathered during these hearings thoroughly documented the powerful productivity-enhancing potential of formally mobilizing employees and their intellectual capital, through such colaborative arrangements as worker design programs, quality circles and team work.

The effectiveness of workforce collaboration in increasing productivity and facilitating innovation was originally discussed in the technology section of this report. The reason for re-introducing the subject into this discussion of worker retraining is that, in order for quality circles and worker design teams to be successful, participating workers must be retrained. Specifically, rank-and-file employees must be equipped with the intellectual skills and tools that will permit them to rigorously measure and evaluate their experience-based observations and judgments. Without such structured, quantitative measures, management has insufficient information upon which to take action in response to worker input. The intellectual tools to enable employees to provide managers with such input include: reasoning and logic; cause-effect relationships; relevance trees and flow-charting; data gathering, sampling and statistical analysis. Using these skills, on the job teams of first line employees are able to provide management with a steady stream of validated findings and recommenations for improving productivity and product quality. Each individual employee's input to this knowledge-generating collaborative constitutes a substantial increase in personal productivity, made possible by worker retrainng that has built upon and augmented the worker's existing intellectual capital rather than ignoring or discarding it.

Workplace experience has shown that employees equipped with such augmented analytical skills are particularly effective in rapidly assimilating and optimally exploiting the full productive potential of new technologies on the job. In a decade of planned high rates of technological innovation, this would suggest that employers would be well advised to retain and retrain a number of their workers in order to assure the most effective utilization of costly new capital equipment. Moreover, since the current wave of new workplace technologies is only the first stage of a 30 to 40 year revolution in all productive processes, there is likely to be an ongoing need for such analytically-skilled rank-and-file employees for a long time to come.

In fact, the principal long-term thrust of all enterprises over the next three to four decades will be the cybernetization of routinized productive operations through the integrated application of computers, robots, communication networks, materials-handlers, data bases, etc. Research experience with such diverse systems development projects as software design, programmed learning, artificial intelligence and economic modeling all show that 80% to 90% of the costs for all forms and levels of automation are from gathering, analyzing and coding the information needed for the design and operation of the automated operation, while only 10% to 20% of the costs are for the actual production and instalation of structures and equipment. This suggests that, as the nation moves toward generalized automation, productive enterprises will need a growing number of operations analysis and systems designers. By providing existing workers with the skills necessary to perform such roles, employers will not only benefit from their retained intellectual capital, but will also be acqiring human resource capabilities that they would have otherwise had to acquire in the labor market at a considerably higher cost.

Such a scenario, of course, would not result in the retention of all productive workers in the face of massive capital investments. But, it would significantly reduce the social and economic costs of worker displacement and de-skilling. Moreover, by mobilizing the existing intellectual capital of skilled, experienced employees to solve workplace problems and manage workplace innovations, such a strategy would be the nation's most cost-effective means of increasing national productivity. Certainly, it would represent the most effective use of education in worker retraining.

If America's educators and trainers merely accept the roles that are likely to be designated to them under any of the various worker retraining proposals that are currently under consideration, they will serve as the agents for de-skilling millions of displaced workers, and permanently reducing their productive capacity for themselves and the nation. If they are to avoid having such socially and economically dysfunctional roles placed upon them within the next five years, they will have to convince the nation's political, business and labor leaders of the productive value of intellectual capital, and the national imperative for mobilizing that resource throughout the nation's workplace. And, they will have to begin that task today!

PART III

IMPERATIVES AND OPPORTUNITIES FOR EDUCATORS

Institutions are servants of society. This is equally true of both public and private sector institutions. Society creates, or enables the creation of institutions in order to do things that individual members of society cannot do by themselves. To the extent that insitutions are good servants, society supports and sustains them. To the extent that institutions are not good servants, society will abandon them in favor of other, better servants.

During the coming decade, American society will be required to cope with substantial economic and technologic change in their lives and in their careers. These will be inevitable changes, which society can neither avoid nor prevent. Thus, society can be expected to call upon its institutional servants to help it master these changes. If existing institutions are unable to respond to these demands effectively, history shows that society will create new institutions to meet its needs.

Thus, the principal imperative for public education during the near-term future will be to help society adapt to the inevitable forces for change. There can be little doubt that, in order to do this, public education will also have to adapt to these same changes. Specifically, if the purpose of education is to provide students -- of whatever age -- with the knowledge and competencies they will need to live effective, rewarding lives in the future, educators will first have to gain a working understanding of that future, in order to be able to design the curriculum content and learning processes that will be most appropriate for the needs of society. A primary purpose of this report has been to provide educators with a basic understanding of the future.

A review of America's "knowable future," in fact, makes it clear that even if society were not being confronted with compelling forces for change, public education would still be faced with imperatives for adaptation and innovation during the coming decade. Demographic realities, for example, will produce a steady increase in the number of children entering elementary school, while reducing high school enrollment. At the same time, long term patterns of migration will generally disperse both population and enterprise out of center cities and into exurbia, while a growing number of urgent national needs for capital resources will place unprecedented requirements upon educators to enhance the effectiveness and efficiency of all public school functions.

Beyond these operational realities, educators will also be faced with imperatives posed by the changing needs of society itself: revising curricula to meet the human resource requirements of a rapidly-evolving, information based, high-tech economy; re-skilling 10% to 20% of the work force; up-grading the life-management skills of nearly 1/4 of the adult population, while providing computer competency for all. Finally, in order to respond to these new operational realities and the new needs of society, educators will have to change themselves as well. Before they can teach new skills, they will have to learn these new skills. Before they can teach more effectively, they will have to learn more effective ways to teach.

Thus, in order to prepare society for a future of change, education will have to change as well. Moreover, in order to serve society effectively, education will have to change before society does, in anticipation of the future. Most important of all, education will have to change intelligently and correctly. If the education profession -- and public education in particular -- prepares society for a less than optimal future, it will guide the nation toward a less than optimal future.

Today, more than at any other time in American history, educators hold the destiny of the nation in their hands. Conventional wisdom among business leaders, politicians, economists and government officials acknowledges that eduction will play a central role in the nation's transition to post-industrial realities. But, as was indicated throughout Part II of this report, most of the educational policies currently being proposed or adopted would appear to be socially and/or economically disfunctional, involving eductors in depressing the general levels of productive education in society and de-skilling millions of workers, while devaluing their intellectual capital. At the very least, such eductional policies will slow down the rate at which the U.S. will be able to successfully exploit the opportunities offered by post-industrial economics and technologies. At worst, it could lead America into a long-term period of social stagnation and of shrinking economic wealth.

If, on the other hand, educators were to adopt the policies, programs and investments (discussed in Part II of this report) that have been shown to be most effective and beneficial, they would lead the nation into a period of rapid social and economic growth. While there are individuals, groups and institutions which espouse such initiatives, the education profession as a whole has not yet offered a set of its own proposals for post-industrial economic development, or education's role in that development. If educators and education are to have any control over their own future -- and the nation's future -- they must act now to counter conventional policy wisdom with a new, more economically productive and more socially hopeful set of proposals. In this critical moment of national transition, education must be not merely a good servant, but, in the words of former AT&T Vice President, Robert Greenleaf, a "servant leader."

STRATEGIC INITIATIVES FOR NEA

At the outset of this report, strategic management was defined as "taking actions that accommodate or exploit inevitable future developments." Clearly, there will be a number of such developments in education's near-term future. Moreover, the ability of America's educators and educational institutions to take strategically sound actions in anticipation of these developments will not only be crucial to the future of education, but to the future of the nation as a whole. This would suggest that NEA, as the principal "institutional servant" of America's educators, should initiate policies and programs that will enable its members to exploit the inevitable realities of the knowable future. As a conclusion to this report, the following pages detail 5 major NEA initiatives which would most effectively address this strategic orientation.

1. A Commitment To Intellectual Rearmament -- Not only do the dynamics of the knowable future clearly pose inevitable requirements for change upon educators and educational institutions, but there is also an unprecedented consensus throughout every level of American society, business and governance that education must be reformed and improved. This consensus clearly signals an impending sea change for education. Rather than fruitlessly expending its resources by criticizing and resisting current reform initiatives, NEA should seek to exploit the enormous potential for progress represented by this rare national commitment to change. In order to do this, NEA must first move from its present defensive position to a leadership position, by developing and energetically promoting its own comprehensive program of educational initiatives based upon the factors summarized in Part II of this report.

Such a "high-yield" educational strategy, in which educational policies and investments would be based upon -- and integrated with -- demonstrated social and economic utilities, was originally conceived of by Dr. Gregg Edwards, former director of the National Science Foundation's research program on "New Knowledge for National Productivity." In order for America to prosper under the new economic realities of the information age, Dr. Edwards argued, the nation would have to embark upon a program of "Intellectual Rearmament." NEA should seek to make such a program a national commitment.

It is important to note that, while current conventional initiatives for educational improvement would not be as effective as a comprehensive program of high-yield reforms, most of the present initiatives would not be incompatible with such a program. Indeed, many of the current initiatives could be incorporated into a comprehensive program, while others would be made unnecessary. But, it is only by taking the professional "high ground," as represented by a comprehensive, rigorously-derived program of innovation and reform, that the NEA will be able to gain the opportunity to refine, redirect or re-prioritize the current proposals for educational improvement.

In those states that have already instituted major educational reforms, NEA should subsume its political resistance under new professional initiatives. Specifically, NEA should promote the establishment of high-yield innovative programs and practices in selected school systems within such states, with the purpose of demonstrating the superior performance of such initiatives in comparison to the overall results produced by the conventional reforms elsewhere in that state. In local contract negotiations, NEA affiliates should press to make the implementation of specific high-yield innovations -- e.g. work-study programs, quality circles, paid sabbaticals for teacher retraining, etc. -- as quid pro quo's for cooperatively accepting mandated reforms such as merit pay, teacher recertification, etc.

2. Creating An Educational Innovators' Network -- Even the policies and priorities established by the most pedestrian educational reforms offer considerable opportunities for productive local innovations, including new teaching technologies, new curricula and new learning arrangements (see Exhibit II). There are, for example, over 6,000 educational soft-ware programs now in the commercial marketplace, with one hundred or more new products appearing every month. This does not take into account the numerous user-produced soft-ware being developed by teachers and instructors throughout the nation. In a time of massive, multi-dimensional innovation, traditional methods of disseminating information on new products and experimental programs are simply inadequate. In order to facilitate the rapid identification and general adoption of the best new practices throughout public education, NEA should create an electronic "innovators' network," to permit its members to share evaluations of their initiatives, and to compare insights from their experiences. The creation of such a network would be the single most beneficial step which NEA and its members could take on their own to enable American public education to take advantage of the opportunities offered by new technologic and economic realities.

3. Re-Skilling America's Teachers -- The most critical component of America's human resource re-skilling efforts must, by definition, be the re-skilling of its teacher cadre. In order for this to occur, NEA must first educate its members about the personal career realities implicit for all teachers in the inevitable forces for change. (This embodies Aristotle's concept of "enlenchos;" a person cannot learn until he or she understands that he/she needs to learn.) For example, computer competency must not be seen as a specialized skill that will be required of only a portion of students in their future lives. Rather, it should be seen for what it is: a basic skill that will be required of everybody in their daily lives; a personal ability as basic a using a telephone, driving a car, or adding and subtracting. This reality means that essentially all teachers must become computer competent themselves, as quickly as possible. NEA must facilitate teacher acquisition of these and other essential post-industrial skills by conducting, sponsoring or certifying effective programs, (including soft-ware), for delivery of such skills. As suggested above, such teacher re-training should also be negotiated as contract benefits. Public schools will also increasingly need systems and

program analysts, soft-ware designers and evaluators, employer-educator liaisons, etc. Instead of hiring such professionals from outside of education, school systems should underwrite the re-training of teachers to fulfill such tasks, thereby retaining and building upon the "intellectual capital" of experienced teachers. NEA should foster the development of such programs, and press for their inclusion in teacher contracts.

4. Quality Circles For Quality Education -- In light of the demonstrated capacity of collaborative workplace relationships to increase productivity, improve employee morale, and promote effective innovation, NEA should vigorously support the institution of "quality circles" and other similar arrangements as a provision of contract agreements. In this area, there is an opportunity for NEA to stake out a leadership position in the labor movement, by developing a career training program to provide rank-and-file teachers with the "worker design" skills required by such collaborative workplace relationships. While there are several prominant management training programs on how to run and use quality circles, organized labor has no such program. Since employee education is a critical element of effective worker involvement programs, it would be entirely appropriate for NEA to take a national leadership role in promoting such efforts, especially within the ranks of organized labor.

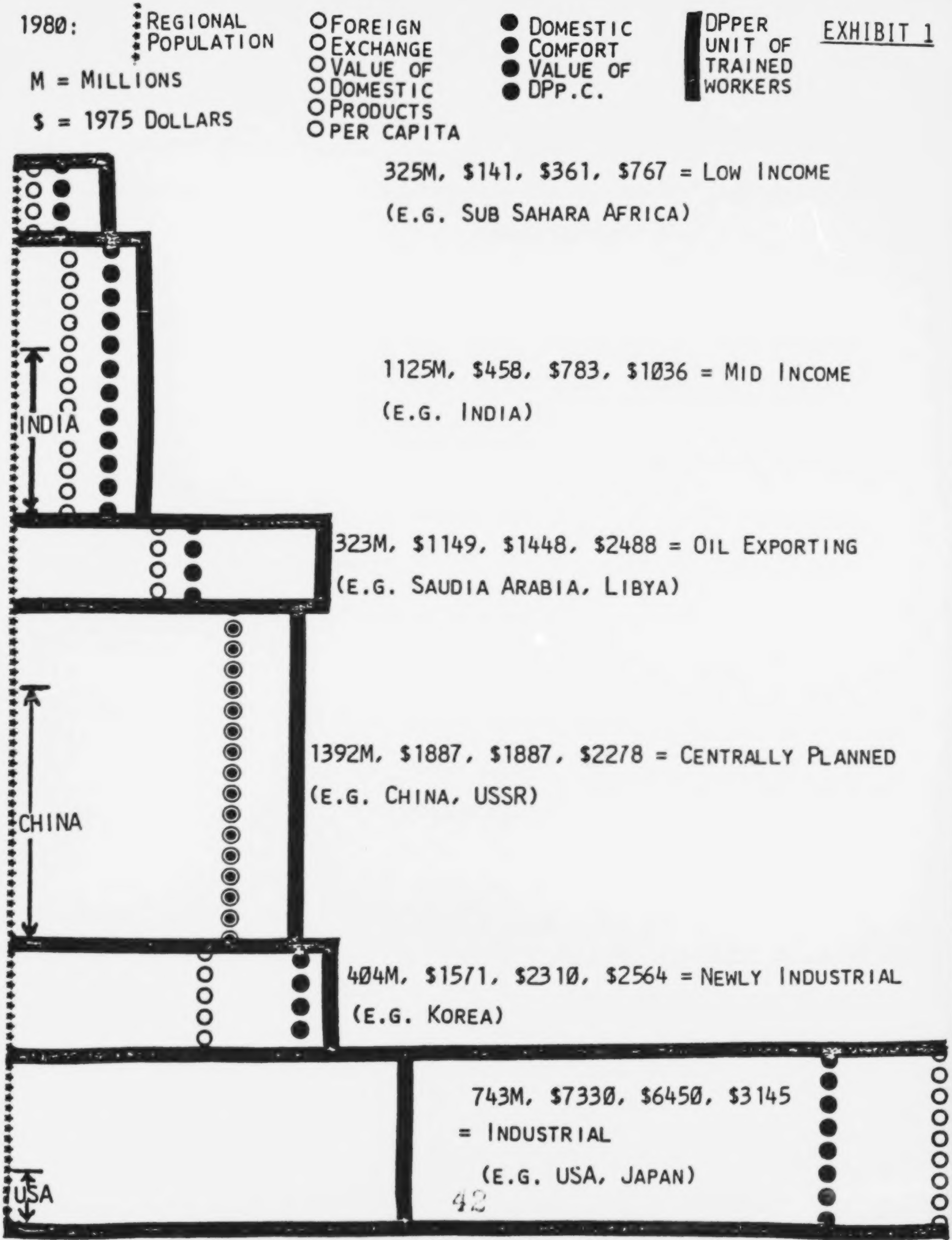
5. Professional Commitments Over Political Commitments -- Both attitude surveys and patterns of personal expenditures substantially confirm the high levels of utility which all segments of American society have for education. It is this utility which the public expects educators and educational institutions to fulfill; it is for this purpose that society spends nearly 10% of the nation's GNP on education. Both the NEA leadership and its rank-and-file members must keep this fundamental reality paramount in their minds as they frame their policies and program initiatives for the future. In particular, educators must be extremely cautious about pursuing social or economic equity through direct arguments for funds and programs earmarked for specific, disadvantaged populations; in such instances, the public is likely to perceive educators as representing special interests rather than the common good.

Increasing productivity is the one "tide" that will surely and truly "lift all boats." Thus, educational policies and programs specifically targeted at raising national productivity must be seen as the educator's most effective means of promoting social and economic equity. This same principle applies equally to state and local levels of activity as well as national. Teachers and public school systems serving deteriorating center city communities, for example, should work with major urban employers to provide their employees with the "worker design" skills that would, in turn, increase their productivity sufficiently to keep those employers from migrating to exurbia. Student internship programs should be used to introduce and sustain quality circle activities among new employers, and among a wide variety of low skill, low pay jobs, in such a manner as to enrich otherwise routine, non-challenging work, and to ultimately increase the productivity of such employment sufficiently to justify increasing wages.

In a 1982 commentary on the need for programs to develop predominantly Black and Hispanic street-youth for productive employment, the National Alliance For Business stated: "If you look at the demographics a decade out, it is clear that we will be doing all of this out of economic necessity rather than out of any moral concern." On the same subject, Robert B. Hill, the former Research Director for the National Urban League has echoed, "If America wants its Social Security checks to keep being paid in coming years, it had better ensure full opportunity and productivity for minorities and women." The conditioned compassion of these statements notwithstanding, they reflect the fundamental realities that educators should plan to exploit in order to achieve their greatest possible impact upon the future social and economic equity of the nation.

At the opening of Part III of this report, it was observed that society creates institutions to serve its needs. It was further observed that, if and when an institution fails to effectively serve society, society will create new and different institutions to meet those needs. This would indicate that, if public education substantially fails -- for whatever reason -- to meet the needs of American society during the coming decade of complex and rapid change, we can be reasonably certain that society will eventually create more serviceable educational institutions. Thus, in a sense, we can be confident that, sooner or later, America will evolve an appropriate and effective educational system for the post-industrial age. The real problem is that, if the country takes too long to evolve that system, the social and economic costs of delay will have been so great as to have substantially impoverished the nation, and to have cost the United States its pre-eminent political and technologic position in the world. Without exaggeration, it is fair to say that what is at stake in educational adaptation and innovation during the coming decade is not the future of education, but the future of the nation. The National Education Association is positioned to play the single most critical role in shaping that future through the policies and programs that it initiates during the next 3 to 5 years.

EXHIBIT 1



Source: Irving B. Kravis and Robert E. Lipsey, The Diffusion of Economic Growth in the World Economy, 1950-80, prepared for the Conference on International Comparisons of Productivity, American Enterprise Institute, September 30--October 1, 1980, Wash., D.C.

EXHIBIT 2

BENCHMARK U.S. EXPENDITURES FOR EDUCATION (1981)

K - 12 (PUBLIC AND PRIVATE)	$128 BILLION P.A.
COLLEGE AND UNIVERSITY (PUBLIC AND PRIVATE)	$73 BILLION P.A.
ALL VOCATIONAL AND NON-COLLEGIATE TECHNICAL TRAINING	$17 BILLION P.A.
EMPLOYEE TRAINING AND DEVELOPMENT (PUBLIC & PRIVATE SECTOR)	$39 BILLION P.A.
TOTAL - ANNUAL U.S. EXPENDITURES FOR EDUCATION (IN 1981)	$257 BILLION P.A.

ADDITIONAL EDUCATIONAL DEMANDS THROUGH 1990

EDUCATE NEW BABY BOOM	$8-$10 BILLION
RETRAIN MIDDLE-AGED, MID-CAREER EMPLOYEES	$60-$150 BILLION
RETRAIN TECHNOLOGICALLY DISPLACED WORKERS	$45-$120 BILLION
RETRAIN ON-BOARD EMPLOYEES TO WORK WITH NEW ELECTRONIC "TOOLS"	$400-$500 BILLION
TOTAL RANGE ESTIMATE	$513-$780 BILLION
AVERAGE INCREASE IN ANNUAL EDUCATION EXPENDITURES (IN CONSTANT 1981 DOLLARS), 1984-1990	$73-$110 BILLION

EXHIBIT 3

Table 1

THE SHIFT TOWARD SMALLER METROPOLITAN AREAS

Size of area (millions)	Percent change in population 1960-70	Percent change in population 1970-80	Aggregate 1980 pop. (millions)
3+	11	-1	39.9
1—3	24	12	50.5
0.5—1	17	12	28.6
0.25—0.5	17	17	24.9
0.1—0.25	16	18	18.5
Under 0.1	15	20	3.6
United States	*13*	*11*	*226.5*

Source: Larry Long and Diana DeAre, "Repopulating the Countryside: A 1980 Census Trend," Science, Vol. 217, pp. 1111-1117, 1982.

Table 2

THE ACCELERATION OF POPULATION GROWTH IN NONMETROPOLITAN AREAS

Size of largest settlement	Percent change in population 1960-70	Percent change in population 1970-80	Aggregate 1980 pop. (millions)
COUNTIES ADJACENT TO SMSAs			
25,000+	9	15	4.1
10-25 thou.	5	14	7.1
Under 10 thou.	-3	14	14.8
COUNTIES NOT ADJACENT TO SMSAs			
25,000+	11	12	5.6
10-25 thou.	9	18	12.5
Under 10 thou.	3	17	16.4
United States	*13*	*11*	*226.5*

Source: Larry Long and Diana DeAre, "Repopulating the Countryside: A 1980 Census Trend," Science, Vol. 217, pp. 1111-1117, 1982.

EXHIBIT 4

FACTORS THAT INFLUENCE THE LOCATION CHOICES OF HIGH TECHNOLOGY COMPANIES WITHIN REGIONS

RANK	ATTRIBUTE	PERCENT SIGNIFICANT OR VERY SIGNIFICANT
1	AVAILABILITY OF WORKERS:	
	TECHNICAL	96.1
	SKILLED	88.1
	PROFESSIONAL	87.3
	UNSKILLED	52.4
2	STATE AND/OR LOCAL GOVERNMENT TAX STRUCTURE	85.5
3	COMMUNITY ATTITUDE TOWARD BUSINESS	81.9
4	COST OF PROPERTY AND CONSTRUCTION	78.8
5	GOOD TRANSPORTATION FOR PEOPLE	76.1
6	AMPLE AREA FOR EXPANSION	75.4
7	PROXIMITY TO GOOD SCHOOLS	70.8
8	PROXIMITY TO RECREATIONAL AND CULTURAL OPPORTUNITIES	61.1
9	GOOD TRANSPORTATION FACILITIES FOR MATERIALS & PRODUCTS	56.9
10	PROXIMITY TO CUSTOMERS	46.8
11	AVAILABILITY OF ENERGY SUPPLIES	45.6
12	PROXIMITY TO RAW MATERIALS & COMPONENT SUPPLIES	35.7
13	WATER SUPPLY	35.3
14	ADEQUATE WASTE TREATMENT FACILITIES	26.4

SOURCE: DR. ROBERT PREMUS
JOINTECONOMIC COMMITTEE
U.S. CONGRESS

High-tech primer: Want to encourage loca industry? Here's a star

Cultivating high-tech development

Congress Office of Technology Assessment surveyed 16 states with programs for developing local high-tech industry. It found that the most common high-tech initiatives fell into six general categories:

R&D and technology transfer

- **Joint research ventures** ... long-term, between universities and companies
- **Research centers** ... technical help and short-term research, for fees
- **Patenting and commercializing** ... the results of university research

Human capital

- **Continuing education** ... for those already employed in high-tech
- **Student internships** ... at existing high-tech companies
- **Retraining programs** ... for high-tech workers, by companies or government
- **Magnet high schools** ... with strong high-tech courses
- **Company donations to schools** ... of equipment and employes to teach

Entrepreneurship assistance

- **Courses and seminars** ... on creating, managing a new high-tech company
- **Evaluation and referral** ... for inventors
- **Consulting services** ... problem-solving and help for entrepreneurs

Financial capital

- **University funding** ... seed-capital funds and venture-capital partnerships
- **Government funding** ... loan guarantees, tax credits, revenue bonds
- **Venture-capital conferences** ... introduce new firms to private capital

Physical capital

- **Changes** ... in land-use and zoning laws to favor high-tech firms
- **Incubator facilities** ... for new companies, with central shared resources
- **Packaging** ... local seed capital with incubator space
- **Research and science parks** ... for companies entering production
- **Sharing** ... university labs and libraries with new companies
- **Improving** ... local utilities, roads, rail spurs and airports

Data gathering, dissemination

- **High-tech task forces** ... to focus attention, recommend initiatives
- **Government marketing programs** ... to attract targeted firms to the area

By Kevin Anderson
USA TODAY

Call it "A Guide to Growing Your Own Silicon Valley."

The congressional Office of Technology Assessment's 98-page background paper, *Encouraging High Technology Development*, to be released today, boils down what the office learned from studying high-tech industrial-development programs in 16 states.

It's as comprehensive a guide as you'll find of what seems to work and what doesn't when it comes to cultivating high-tech — all gleaned from the cultivators.

"No single factor explains why some communities and regions have been more successful than others in nurturing and benefiting from high-technology development," says the study.

"A strong research university, a skilled labor pool, available financing, the presence of corporate headquarters, transportation, good climate, cultural amenities — all might be desirable or necessary factors, but they're not always enough," the study says.

The office said communities can increase their chances for success by:

■ Identifying and focusing on local needs and resources, rather than copying what others are doing: "The successes of California and New England in the 1970s may not prove useful models for the Midwest and other regions in the 1980s."

Huntsville, Ala., for example, needed new jobs when the space program was scaled back in 1970.

It had a valuable resource in the hundreds of engineers and technicians laid off in the cutbacks at the Marshall Space Flight Center. So local leaders established a branch of the University of Alabama and helped former Marshall scientists set up their own companies in a research park.

■ Adapting to external constraints, such as climate or the nearness of high-tech centers.

Austin, Texas, knew in the 1960s that it needed to expand its job base, but it lacked a good geographic location for heavy industry and a climate and populace that would tolerate pollution. Leaders targeted the recruitment of high-tech industry, using the University of Texas' academic resources as a magnet.

■ Linking high-tech development to overall development programs. "High-technology initiatives that form part of a broader development strategy appear to produce the most substantial results.

"Most state officials, in fact, consider their high-tech initiatives a logical and unavoidable extension of more traditional industrial development programs."

■ Local initiative and partnership. The best programs are those started by local leaders, not states, the report says.

A vital ingredient in any good program is cooperation and partnership among local government, state government, local universities and schools, and existing local businesses.

Doing that, the study says, requires community agreement on problems and goals, and — above all — strong public and private leaders "who combine an established track record for innovation with a broad view of the community's resources and problems."

■ Sustained effort — often for 10 or even 20 years — before a significant level of high-tech employment can be generated.

The office acknowledges criticisms often leveled at high-tech development: that job projections are unrealistic, that the potential for reviving depressed areas is overstated, that the mad rush to woo high-tech could lead communities to overlook development possibilities better-suited to them.

But hundreds of USA communities have high-tech programs, spurred on by the emerging belief that even if a community can't become a high-tech research center, like those around Boston, in North Carolina or in California, there still might be a healthy piece of action in producing mature high-tech products.

The biggest danger, the study concludes, is not disappointment but a lack of coordination with other states. That might lead to a "zero-sum game of raiding other communities for their high-tech plants," rather than stimulating overall growth.

For copies of *Encouraging High-Technology Development*, write the U.S. Government Printing Office, Superintendent of Documents, Washington, D.C. 20402. Ask for GPO stock number 052-003-00942-1. The price is $4.75.

EXHIBIT 6

PRODUCTIVE FACTORS IN EDUCATION

MOST IMPROVEMENTS IN ABILITY

* INCREASE BY C. .2 S/YR OF AGE (NO SCHOOL)

* INCREASE BY C. .3 S/YR OF SCHOOL

(ALMOST INDEPENDENT OF TEST AND SCALE)

		USUAL YEARLY PROGRESS
PRODUCTS OF SCHOOLING:	COMPETENCY	.2 S/YR (.5S/YR FOR
	COMMITMENT	.2 S/YR SCIENCE INSTRUCTION)
	KNOWLEDGE	.35 S/YR
	STRATEGIES/ SELF-ORGANIZATION	.35S/YR

FACTORS ASSOCIATED WITH SUBSTANTIAL IMPROVEMENTS OVER USUAL RESULTS.

PERSONAL	o ABILITY (IQ)	X1.55SA
	o SELF CONCEPT (SIMILAR TO "COMMITMENT")	X1.4SS
	o STYLE OF LEARNING (SIMILAR TO "STRATEGIES")	X1.5SL
MATERIALS	o "QUALITY"	+2S !!
	* STRUCTURED ("ROAD MAPS", CLEAR OUTLINE)	
	* REVISED (TEST, AND BRIDGE GAPS, ROUGH SPOTS)	
	* CONCRETE (EXAMPLES WITH GENERALIZED STATEMENTS)	
	o GUIDANCE	+.25S
	o EXTRA TIME	X1.25ST
ENVIRONS	o PARENTAL INVESTMENT (TIME AND ATTENTION)	X1.36SPI
	o SOCIO-ECONOMIC STATUS (RICH SOCIAL AND CULTURAL FAMILY BACKGROUND)	X1.25SSES

METHOD OF INSTRUCTION

PROJECTS (PEER AND PEER TUTORING) (DEVELOP MOTIVATION; EACH ONE TEACH SOME)	+2S	!!
'PRECISION' TEACHING (TEACHER GETS WEEKLY, MULTI-DIMENSIONAL SCORES OF ADVANCES MADE BY EACH STUDENT)	+1.1S	!
PERSONALIZED SYSTEM OF INSTRUCTION (SELF-PACED, MASTERY LEARNING, MODULAR CURRICULUM STRUCTURE)	+.5S	
COMPUTER ASSISTED INSTRUCTION		
ELEMENTARY	+.5S	
HIGH SCHOOL AND COLLEGE	+.25S	

CLASSROOM

	#	
SIZE	40	x1.0
	20	x1.3
	1	x1.6
PEER ABILITY		x1.5SA
SOCIAL MORALE (ÉLAN)		x1.25SE

TEACHER: VARIANCE DOMINATED BY 'PERCEIVED INJUSTICE'

10% TRUANT

30% LOSE INTEREST

Source:
Developed using materials and methods suggested by H.J. Walberg (University of Chicago)
NSF Research Project for a Meta Analysis of the last 50 years' research results in education.

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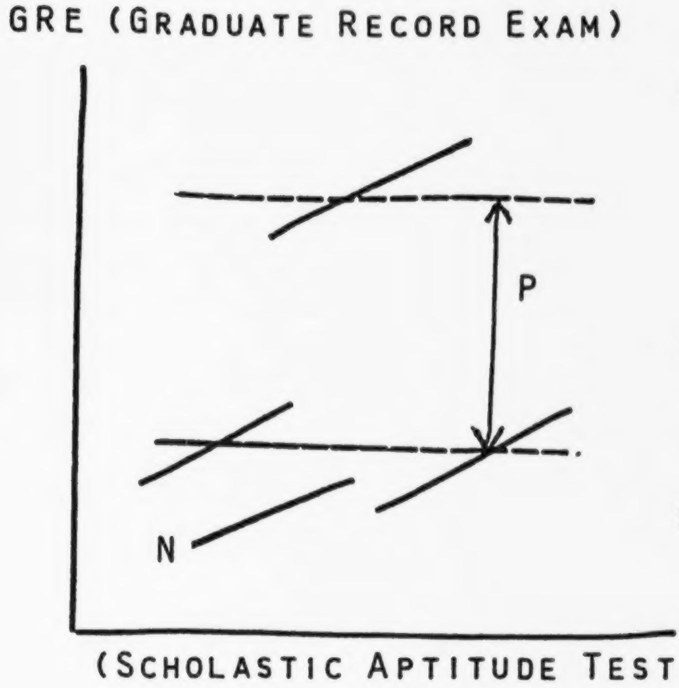
EXHIBIT 7

IMPACT OF COLLEGE "ENVIRONS" ON APTITUDE

o ABOUT 10-20% OF SCHOOLS HAVE A PROGRAM WHICH "PERFORMS" 20-50% BETTER THAN OTHER SCHOOLS.

o THE SUPERIOR PROGRAMS MAKE A MARKEDLY DIFFERENT "ENVIRONMENT" THAN OTHER SCHOOL PROGRAMS.



PERFORMANCE CURVE:
OUTGOING SCORES (GRE) BY STUDENTS WHO ENTERED WITH CERTAIN SCORES (SAT)

N=NUMBER OF SCHOOLS WHOSE PERFORMANCE CURVES CLUSTER OR OVERLAP

S=PERCENTAGE OF SCHOOLS WITH MARKEDLY SUPERIOR PROGRAM

RESULTS

		S%	P%
PROGRAMS:	NATURAL SCIENCE	13	38
	SOCIAL SCIENCE	8	50
	HUMANITIES	20	20

Source:
David Rock, Educational Testing Service, Princeton, New Jersey, Analyzed Data on 95 Colleges.

I. A FEW SCHOOLS HAVE A MARKEDLY SUPERIOR PROGRAM.

"SUPERIOR": THE PROGRAM'S STUDENTS ACHIEVE 20-40% MORE THAN SIMILAR STUDENTS AT OTHER SCHOOLS.

(N.B. ONLY ONE SCHOOL IN 95 HAD TWO SUPERIOR PROGRAMS.)

II. THE SUPERIOR PROGRAMS WITHIN EACH BROAD FIELD HAVE SIMILAR CHARACTERISTICS.

(S = % OF SAMPLE WITH SUPERIOR PROGRAMS)

(P = AVERAGE % OF SUPERIOR PERFORMANCE)

NATURAL SCIENCE: S = 13% P = 38%

FACTORS:

- STUDENT INVOLVEMENT (E.G. FACULTY PROJECTS)
- EXTRA USAGE OF CLASS/LAB
- NOT "PRACTICAL"

SOCIAL SCIENCE: S = 8% P = 50%

FACTORS:

- CRITICAL MASS OF FACULTY AND STUDENTS
- ACTIVISIM AND STRONG INTERACTIONS

HUMANITIES: S = 20% P = 20%

FACTORS:

- OUT OF CLASS LEARNING (LARGE AMOUNT OF DIVERSITY OF ACTIVITIES/ENRICHMENT)
- HIGH SELECTIVITY, DOCTORAL FACULTY

III. MOST PROGRAMS AREN'T EXPENSIVE, DON'T FOLLOW "PRESTIGE" MODEL.

- NOT DEPENDENT ON COST OF LIBRARY, BUILDINGS, FACILITIES
- KEY FACTOR: INTENSITY, MEANING AND TIME-INVOLVEMENT OF RELATED ACTIVITIES
- ONLY HUMANITIES (WITH WEAKEST SUPERIOR PERFORMANCE) HAD ANY "TRADITIONAL" MEASURES (SELECTIVITY, NUMBER OF PH. D.'S)

EXHIBIT 8

Jobs and Grads in the '80's

o Great Surplus of College Grads

- 40-70% more grads than appropriate jobs (40% if long term economic growth; or 70% if recent rate)
- both assuming current economic, trade, and staffing structures

o Surplus must downgrade or move

- Big decrease (-12%) - absorption by Professional & Technical
- Small increase (5%) - absorption in management and high ticket sales
- Huge increase (100%) - absorption in clerical, service, retail sales, blue collar
- Major relocation - in Sunbelt and West to new regions (mostly small towns/rural)

o Some short-term spot shortages in narrow specialties

- Limited mostly to unexpected start-up projects
- "Shortages" unimportant if shift hiring practices and retrain

o Great shifts in demographics

- 25% decrease in young people
- 66% of job applicants will be women (up from 50%)
- 28% will be Black or Hispanic (up from 18%)

Jobs and Grads in the '80's

Overview

Demand Unpredictable. In a dynamic world one expects a changing economy: some rapid and many secular changes due to changing business conditions, tastes, demographic trends and associated shifts in needs, national priorities and major programs, and new or newly implemented technological developments. Given the tendency for technology to be introduced in waves, and for the national or international setting to change, it seems certain that we will have various imbalances in supply/demand.

Retraining. There is an enormous ability of most of the workforce to transfer from one skill area to another. Even in highly specialized technical areas like engineering, only half of the job holders have degrees from the disciplinary field in which they are working; the rest may have degrees in other fields of engineering, technicians upgraded to work as engineers by on-the-job-training, or transfers from math and the physical sciences.

Supply Overschooled. Unless major changes take place, we will have far more college grads than we have appropriate jobs. And the oversupply will continue to be especially great in fields like the arts, humanities, and some of the social sciences. But there is also a hard core of unemployed who lack necessary background for most career jobs or training.

Shortages. Some imbalances occur because the traditional pay scale is not enough to retain workers, or recruit them into prior training: nurses, science teachers and engineering professors. But this is not a supply problem per se.

Antidote? Perhaps it is no longer possible to train young people for an occupation they can hold for the 40 to 50 years of their working lives. We should consider reorienting education for life-long adapability, and for some highly adaptable means of shifting job lines.

Supply Outlook for the '80's

New Demographics. Because of the decline in birth rates starting in 1960, there will be a deceleration of new entrants during the '80's. The age of the work force will move up. Women will account for 2 of 3 net additions during the '80's. Blacks, as a percentage of the labor force, will move from 1 in 7 to 1 in 5.

College Grads. During the '70's, 20% of college grads took jobs not requiring a college background, due to a large overproduction of college grads compared to the growth in jobs with such background. This has contributed to much labor discontent.

At the same time, the rate of grads entering Professional, Technical and Kindred (PTK) jobs dropped dramatically from 67 to 55%. There was only a slight increase (5%) of grads entering jobs in management and hi ticket sales. Instead the percentage of grads doubled in clerical, blue collar, service jobs and retail sales - fields not well using college level education.

During the '80's, demand for college grads will again be mostly in the PTK category - replacing workers retiring or leaving for school or home responsibilities. There will continue to be upgrading of some jobs formerly only requiring a high school education (e.g. managerial, and non-retail sales jobs) to utilize the more complex skills of the grads.

There will still be huge numbers of college grads who will be in jobs beneath their training. Of 15M grads entering the labor force during the '80's - 60% new grads and the rest reentrants from grad school or family responsibilites - there will be only 11 to 13M appropriate jobs, depending on economic and rade conditions. If the economy improves an does only as well as uring the '70's, the new jobs will e the lower figure, with 3M surplus rads - about the same 20% surplus s in the '70's. But they will be ompeting with the almost 4M surplus rads who have not found work ommensurate with their training, so there will actually be a surplus pool of about 40 to 50% greater than the demand for complex job skills. If the economy remains flat, then the surplus pool will be closer to 60-70%.

Many future grads will not find jobs in the occupations of their choice, and will experience periods of nemployment, job-hopping, and elocation to new regions before inding satisfactory employment, if all. They will also be in ompetition for desirable jobs with many non-graduates who will be working harder to offset the hiring advantage that the degree to some extent confers.

Demand Outlook for the '80's

Shortages ? Some occupations seem likely to have personnel shortages for some time - most strikingly computer specialists, since there only about 10% of new hires have a college degree. Concommitant with the growth in computers and electronics, and a possible defense build up, there may be some shortages in electrical and aeronautical engineering. But given the dramatic increase in engineering enrollments, shortages are unlikely (except in narrow specialites for short-term start-up projects).

In the other major growth industry, health, the supply/demand picture will be in closer balance, except for some geographical shortages for advanced medical specialists, doctors, dentists, and some surpluses in fields, for example, surgery.

We will continue to hear about "spot shortages" - however, note that this is a very tricky term. Most often what is going on is that in specialized areas employers are forced to change their hiring patterns and accept a group of lesser preference.

In only a very few occupations are recent school graduates the predominant source of supply, - but they are often preferred by employers because of their willingness to move, readiness to be trained, and relative inexpensiveness to take on and let off.

In a field such as accounting or electrical engineering the order of preference for an employer goes something like this:

1. The top fresh grads from the top engineering schools.
2. The top fresh grads from less-well-thought of schools.
3. The second rank grads from the top schools, then from lesser schools.
4. People with recent experience who live nearby (to avoid relocation costs).
5. People with less recent experience, and further away.
6. People with experience in related fields who might be retrained.

Shifts in Job Sectors

Changing Numbers of Jobs:

Fastest Growth:
  Medical: nursing homes, labs and associated facilities; hospitals; medical and dental offices.
  Office Equipment: typewriters, computers, copiers, periferals, phone systems...
  Coal mining...

Largest Numbers:
  Retail services: eating and drinking places, goods;
  Biz services: accounting, software, tax & financial counsel...
  Hospitals

Sharpest declines:
  Farm - dairy, poultry
  Alcoholic beverages
  Leather goods - tanning & prep.
  Logging
  Synthetic fibers

Kutscher, R.E., Commissioner of Labor Statistics, "Jobs Outlook, 1982", Report to the Joint Economic Committee of the Congress,

EXHIBIT 9

SUMMARY OF GENERIC SKILLS*

Mathematics Skills (11 areas; 34 skill areas; 192 sub-divisions of skills)

1. *Whole numbers:* Read, write, and count; add and subtract; multiply and divide; word problems; round off
2. *Fractions:* Read and write; add and subtract; multiply and divide; word problems
3. *Decimals:* Dollars and cents; read, write and round off; multiply and divide; add and subtract; word problems
4. *Percent:* Read and write; ratio; proportion; percentage; rate; principle
5. *Mixed operations:* Equivalents; order of operations; word problems; quick calculations; average
6. *Measure:* Read graduated scales; read verniers; time; weight; distance; capacity
7. *Metric measure:* Weight; distance; capacity; weight conversion; distance conversion; capacity conversion
8. *Geometric figures:* Forms and figures; angles; draw, sketch; perimeters; areas; volumes
9. *Drawings and graphs:* Read graphs; read scale drawings; read assembly diagrams; read schematic drawings; draw graphs; measure from scale drawings; draw to scale
10. *Algebra:* Single variable, open sentences; single variable, powers and roots; solve given formulas; integers and rationals; variables and expressions; two variable, open sentences; quadratics
11. *Calculations:* Logs; slide rule; trigonometry calculations; calculator

Communications Skills (7 areas)

12. *Words:* Plurals; prefixes, suffixes, and root words; contractions and abbreviations; dictionary; synonyms, antonyms, and homonyms; meaning and context; books
13. *Listen:* Literal comprehension; interpretive comprehension; evaluative comprehension
14. *Talk:* Pronunciation; diction and word choice; fluency; organization of ideas; ask 6W questions; give information and directions; use telephone
15. *Read I:* Literal comprehension; interpretive comprehension; evaluative comprehension
16. *Read II:* Forms, notes; letters or memos; charts and tables; manuals; Roman numerals X; Roman numerals XXX; Roman numerals M
17. *Write I:* Phrases on forms; sentences on forms; paragraphs on forms; sentences; paragraphs; short notes; take notes
18. *Write II:* Form letters; single paragraph letters; internal memos; business letters; information reports; recommendation reports; technical reports

Interpersonal Skills (7 areas)

19. *Attending behaviors:* Physical; cognitive; reactive; covert
20. *One to one conversation:* Elementary conversation; task focused conversation; express own point of view; personable conversation; persuasive presentation

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* Kawula, H.J., & Smith, A. DeW. *Generic skills: Handbook of occupational information.* Prince Albert, SK: Canada Manpower and Immigration Department, Training Research and Development Station, 1975.

21. *Group discussion:* Preparation; presentation of information or directions; control group decision making; group maintenance; participate in group discussion; respond to information or directions; persuasive presentation

22. *Oral presentations:* Preparation; factual information; listen, respond; conceptual; persuasive; reactive

23. *Instructional communication:* Establish training; instruction; demonstration; monitor; evaluate

24. *Supervisory communication:* Give directions; demonstrate; give praise; give discipline; prepare evaluation reports

25. *Interview/counsel communication:* Preparation; closed questions; open questions; confrontation; interview job applicants; negotiate

Reasoning Skills (9 areas)

26. *Obtain job related information:* Tools, materials, and equipment; methods and procedures; sequence; other information; theories

27. *Organize information:* Sort objects; sort data; rate; rank; develop classifications

28. *Estimate:* Time, weight; distance; area; capacity; cubic measures; costs

29. *Tasks:* Sequence; priority

30. *Objectives and methods:* Goals; activities; alternatives; criteria; priority; analysis; deduction

31. *Diagnosis:* Cause and effect relationships; possible problems; priorities; possible methods; probing questions; use senses

32. *Problem solving:* Relevant information; alternative statements; select statement; alternative solutions; select alternative

33. *Plan and coordinate:* Activities and sequences; outline plan; identify resources; estimate resources; critical activities; detailed plan; resource requisitions

34. *Implement work:* Monitor results; standards of quality; standards of quantity; standards of completion time; priorities of standards; authority and responsibility; update plans

COMPOSITE LIST OF TRANSFERABLE SKILLS*

Intellectual/Aptitudinal

- Communicating
- Problem Solving
- Analyzing/Assessing
- Planning/Layout
- Organizing
- Decision Making
- Creativity/Imagination/Innovation
- Problem Identification/Definition
- Managing One's Own Time
- Basic Computation
- Logical Thinking
- Evaluating
- Ability to Relate Common Knowledge or Transfer Experiences
- Coping with the Labor Market and Job Movement
- Understanding Others
- Synthesizing
- Marshalling Available Resources
- Accommodating Multiple Demands
- Judgment
- Foresight
- Trouble Shooting
- Job Awareness
- Mechanical Aptitude
- Typing
- Accounting
- Implementing
- Self-Understanding, Awareness, Actualization
- Situational Analysis
- Assessing Environments/Situations
- Understanding Human System Interactions
- Organizational Savvy
- Conceptualization
- Generalization
- Goal Setting
- Controlling
- Quantitative Thinking
- Dealing with Work Situations
- Finance
- Tool Usage
- Bookkeeping
- Artistic Ability
- Business Sense
- Tolerance of Ambiguity

Interpersonal

- Working with, Getting along with, or Relating to Others
- Managing, Directing, or Supervising
- Empathizing, or Being Sensitive to Others
- Teaching, Training, or Instructing
- Counseling
- Motivating
- Gaining Acceptance, or Building Rapport
- Helping, or Cooperating
- Cultivating Cooperation
- Selling
- Accepting Supervision
- Delegating
- Instilling Confidence
- Team Building

Attitudinal

- Diligence, or a Positive Attitude toward the Value of Work
- Receptivity/Flexibility/Adaptability
- Determination/Perseverance
- Acceptance/Appreciation/Concern for Others
- Responsibility
- Willingness to Learn
- Ambition/Motivation
- Self-Confidence
- Self-Discipline
- Pride
- Enthusiasm
- Patience
- Self-Actualization
- Assertiveness
- Honesty
- Loyalty
- Reliability
- Risk Taking
- Compromising
- Kindness

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* Wiant, A.A. *Transferable skills: The employers' viewpoint* (Info. Series No. 126). Columbus: The Ohio State University, The National Center for Research in Vocational Education, 1977.

EXHIBIT 10

THE HUMAN FACTOR IN INNOVATION AND PRODUCTIVITY

EXCERPTS FROM TESTIMONY BEFORE THE
COMMITTEE ON SCIENCE AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

SEPTEMBER 9-15, 1981

Excerpts of Testimony Before the House Science and Technology Committee

Hearings on "The Human Factor in Innovation and Productivity" (September 9-15, 1981)

1st Witness: Michael Maccoby, Founder/Director of the Harvard University Program on Technology, Public Policy and Human Development, and Director of that program's 10-year study of Technology, Work, and Character.

"Over the past 10 years, we have learned that hierarchical, policing-style management causes resentment, sabotage, costly absenteeism, and a negative employee attitude toward the enterprise. Conversely, the Japanese success at participative management and the GM-UAW 'Quality of Working Life' (QWL) program have dramatized the fact that--properly organized--workers today can manage themselves, raising the level of their performance and reducing the costs of administrative overhead and wasted effort at the same time that they also find their work more satisfying. Furthermore, if adequately trained and informed, both factory and office workers contribute to a continual process of innovation, through which small improvements and cummulative savings add up to be just as important as more dramatic innovations.

In the U.S., two types of organizations are at the forefront of such managerial innovations. One type is similar to Japanese paternalism; these are firms which guarantee job security, and which manage according to a philosophy which emphasizes respect for the individual employees and encourages continual learning. This includes such U.S. firms as Hewlett-Packard and Proctor & Gamble. The second type of innovative management is found in those unionized organizations which are able to work co-operatively with a strong, progressive union. The GM/UAW and ATT/CWA collaborations are examples of such arrangements where management, working in a 'limited partnership' with the union, gains co-operation and flexibility."

"As American enterprise reaches for new technology to improve productivity, it must re-examine its standard approaches to organizational design and systems engineering. Traditional production technology like the assembly line--designed to maximize control and the mechanistic interchangability of people-- no longer proves productive when compared with new socio-technical designs built on the principles of increased teamwork and individual responsibility."

"New forms of socio-technical design become more feasible and necessary as computers and micro-processors allow greater decentralization and flexibility in designing away some of the worst jobs or job features. As more routine tasks can be automated, new jobs demand more intellectual skills with greater autonomy and responsibility. But making good use of new technology requires new attitudes and practices by both management and union leadership; otherwise, technology will not fulfill its promise of increased productivity. Professor Richard Walton at the Harvard Business School has presented research showing that unless employees participate in the design and implementation of new office technology, costly resistance depresses performance. Yet in spite of this and other evidence, most businesses and government agencies expect new technologies to work efficiently according to old hierarchical, controlling managerial principals."

"In government as well as business, managerial innovation pays off. Here in Washington, I helped to establish a work improvement program in the Department of Commerce, with the co-operation of American Federation of Government Employees. Workers met to identify and solve production problems. The program resulted in significant productivity gains and technical innovations suggested by the workers. At the same time, grievances practically disappeared."

"Two years ago, the Joint Economic Committee of Congress commissioned me to answer the question: 'Is the work ethic deteriorating in America?' A number of studies combined with my own research, indicate that worker values are changing in America, but that the work ethic is still strong. U.S. employees increasingly object to work that does not allow them to use their brains, and which robs them of dignity. They want to learn at work and to have a say in how that work is carried out. Otherwise, they become resentful and cynical. . . .""

Testimony before the House Science and Technology Committee on September 16, 1981 on "The Human Factor in Innovations and Productivity"

2nd Witness: James W. Driscoll, Assistant Professor, Sloan School of Management, MIT

"The technological path of office automation in the U.S. shows little economic benefit and threatens substancial social costs. An alternative, more humanistic path could lead to both economic and social benefits. The principles underlying a humanistic use of technology are well known, and apply both to office and to factory work. Current organizational practices, however, make the realization of such benefits unlikely. "

"Human energy is the key to both productivity and innovation. Economists are able to ascribe only a modest portion of productivity improvement to investment in new capital equipment. Indeed, one intensive longitudinal study has shown that the bulk of productivity improvement has been due not to major acquisitions of new technology but to a continuous process of suggestions and modifications made by workers and managers. "

"Experiments to improve productivity in offices reveal a consistent pattern of success: productivity is more likely to improve (1) where office workers participate in the design, selection, and implementation of new office technology; (2) where pay and other organizational rewards are redistributed equitably to reflect technological change and productivity gains, and (3) where human resource management practices-such as increased promotional opportunities, enriched job designs, training in participative supervision, etc.--encourage worker identification with organizational objectives. By contrast to this proven pattern for productivity, unfortunately, the usual automation of office work follows a traditional path of technological development and implementation which I have labelled "systems analytic."
Such applications reflect what Douglas McGregor long ago called "Theory X" assumptions about human nature. The purpose the systems analytic approach is to simplify office tasks, control office workers, and provide information to managers and executives.

Not surprisingly, given this discrepancy between typical office automation projects and proven measures for increased productivity and innovation, there is precious little evidence of any economic benefits accruing to employers. Given the absence of tangible cost savings, most vendors today emphasize the "value added" or "soft dollar" savings. While such intangible benefits are appealing to those managers and professionals whose power and status are enhanced by office automation projects, such benefits must be weighed against the social costs of the current technological path of innovation."

The potential harmful effects from the "systems analytic" path of office automation are many. In addition to the decreased quality of work life--due to job routinization and more rigid supervisory control, which produces reduced worker motivation and innovation--serious health hazards are posed also by office automation. These hazards include psychological stress of machine paced, computer-mediated work; there is no question that visual display units physically strain the eyes, neck, and back. And, while adequate rest breaks and proper equipment design can eliminate most terminal-related health problems, American employers and equipment manufacturers have negligently slowed progress in these areas by comparison to their European counterparts."

3rd Witness: Raymond M. Demere, Jr., Vice-President of Manufacturing Services, Hewlett-Packard Company, September 16, 1981.

"Over a two-year period, teams of production workers and engineers made a series of improvements in their circuit-board soldering process. They were able to reduce the number of defects from 3500 parts per million to 20 parts per million. At the same time, the production cycle time was reduced from 4 weeks to 3 days. Productivity per worker and per square foot of work space also improved dramatically. These are the kinds of examples that have made our managers so enthusiastic about improving our quality and productivity."

"Now, there are two ways to produce high quality products: (1) Build in defects, find them and fix them; or (2) Use perfect parts in a controlled, "defect-free" process; i.e., "do it right the first time!" Traditionally, we have used the first approach--build in defects, find them, fix them. But when we took a close look, you can imagine how surprised we were to learn that an estimated 25% of our manufacturing assets were tied up in finding defects and fixing them, or reacting to poor quality. This was costing us about 20% of our sales. Inspecting, troubleshooting, rework, and more inspection--what might be called the "Brute Force" method of quality assurance--was costing us much more than we thought. One division estimated that if it did everything right the first time, it could get by with 1/3 fewer people, 1/4 less floor space, and 2/3 less inventory."

"In December 1978, one of our divisions which makes computer peripherals--such as printers and tape drives--began a campaign called "Improved Methods and Products" or "IMP". This campaign is still going on. Every employee is urged to participate: IMP forms are conveniently placed around the plant. Employees fill out the forms and present their ideas to their supervisors. The supervisors, in turn, present the ideas at special IMP meetings, once a month. If an idea is accepted, a tiny outline of a light bulb is engraved on the employee's name badge; this light bulb--symbol of the IMP Program--provides recognition to those who contribute. All told, 558 ideas have been implemented; more than 321 employees have had a part in developing suggestions, and the estimated cost savings in less than 3 years has been greater than $5 million."

"We continue to find that the people closest to an operation--the workers executing the process--can contribute greatly to the improvement of the process. We have borrowed the Japanese quality circle technique. During the past 4 years, more than 550 quality teams have been formed within Hewlett-Packard. They have contributed mightily to improved quality/productivity and to the improved quality of work life of the participants."

4th Witness: Einar Thorsrud, Director, Work Research Institute, Oslo, Norway

"Small countries are forced by their relative power situation to be alert to basic changes in their environment. We must rely on our adaptability and learning capability rather than our power or influence on others. Therefore, it was quite natural for labor and industrial leaders in Norway in 1960-61 to ask themselves the following basic question: 'What needs to be done—on the basis of our high standard of living and the good welfare system we have created since the 1930's—to increase the creativity and involvement of people in deciding their own futures?' In other words, how were we to broaden the base for democracy and human development. There were clear signs, particularly among our young workers, that they wanted something more out of work than money and safe employment.

This concern was the basis for the so-called Industrial Democracy Project, jointly sponsored by labor and management, and later, by government. In Phase A of the Project (1962-64), we explored the value of worker representation on the boards of companies. In Phase B (1964-72), we conducted a series of demonstration projects, which explored the enhancement of human development and worker performance through increasing employee control over their own situations. (Today, these would probably be called "Quality of Work Life" projects.) The principal conclusions of the Industrial Democracy Projects can be summarized as follows:

First, board representation, by itself, does not significantly increase the influence of rank and file workers on decisions affecting their future.

A second set of results, regarding increased employee participation in everyday work life decisions, in planning, and in job, and organizational design, showed considerable gains for workers as well as enterprises. Absenteeism and employee turnover decreased, while productivity went up. The redefinition of 'productivity' itself, from a simple measure of worker output per hour to the overall *effectiveness* of productive units was an important result. Structural changes in work organizations were undertaken to replace hierarchical, bureaucratic, or what we call "uniform" types of organization. This involved the introduction of self-managing (or partly autonomous) groups, overlapping work roles (in what is called a "matrix" organization,) plus horizontal and vertical rotation between jobs and new forms of decentralized planning, co-ordination, and control of quality and cost. All of these new forms were used in different combinations to suit local needs, particularly when new forms of technology were introduced.

A third set of results, regarding the implementation or diffusion of new forms of work organization, showed that direct transfer of a particular structure or methodology from one enterprise to another—or from one branch to another—is difficult, at least so long as the new forms are not well-known and generally accepted throughout management and unions. Simple copying or any form of mechanistic replication will not work!

A fourth and final set of findings from the Industrial Democracy Projects led to a new Norwegian law on work environment (1977). This new law not only set new physical standards for working conditions, but also included psycho-social factors. And most important, it instituted the rights of employees and their specially trained shop stewards to be personally involved in defining what is a good and safe workplace, and how it can be improved. This last item has turned out to be the principal basis for the development and diffusion of new forms of work organization in Norway today."

"It is my firm belief that the employment problems that the industrialized nations are facing today are only the beginning of a total redefinition of the meaning of work and employment. A total reallocation of creative human activity between different sectors of society is needed to cope both with transitional unemployment and with other social problems which will not be solved simply by introduction of the latest forms of technology. What we need to do is to make a choice of technology and matching organizational arrangements within a policy framework providing for the participation of all involved parties.

5th Witness: Judith Gregory, Research Director, National Association of Office Workers

"The way computer technology is being introduced into offices today not only causes suffering among millions of office workers, but also does not serve the goal of increasing productivity. Many of the features of office automation which managers extol--enforced discipline and standardization, computerized work performance monitoring--represent new strictures which plague office workers, undermine potential gains in effectiveness, cause new inefficiencies, and take a great toll on people."

"As the U.S. continues the historic transition to an 'Information Economy', clerical workers--who number nearly 20 million and account for nearly one in five of all U.S. employees--will be more affected by wide-spread office automation than other sectors of the white collar workforce. Women hold about 80% of all clerical jobs; according to the Bureau of Labor Statistics, clerical work employs 35% of the nation's working women. Despite the importance of office work to the economy, it is one of the least rewarded jobs in our workplace. Average pay for female clerical workers hovers around $10,000 p.a., and in 1979, fully 1/3 of all full-time women clericals earned less than $7,800 p.a.."

"Innovations in new office technology have a great potential to upgrade office jobs, skills and pay, and to provide more avenues for job satisfaction among clerical workers. Yet the opposite trends are occurring: deskilling, devaluing and degrading of clerical jobs, declining promotional opportunities, and rising potentials for large-scale employment losses and job-related health risks. While office automation has improved jobs for some people--and has the potential to upgrade office jobs overall--most women office workers who experience office automation find themselves in jobs that are more closely supervised and controlled, and increasingly "specialized," meaning that they tend to be doing smaller fractions of the larger task."

"We are witnessing a revival of the industrial rationalization of work in the office. For example, at a major Midwest firm recently, the jobs of a group of secretaries were broken down into five sub-tasks when word-processing was brought in. One sub-task was initial entry, another was entering revisions, another proof-reading, and so on. Under this new arrangement, each women must complete a "tour of duty" in each "sub-task" before she can be considered for advancement. In other words, she has to be 'promoted' four times just to get back to where she started!

"For the majority of clerical workers, office automation means working harder and faster--for more people at once--without getting paid better. In 1979, full-time word-processing operators made only $7 more per week than conventional typists, despite claims by vendors that productivity soars from 50% to 500% with the introduction of word processors. In the banking and insurance industries--among the most computer-intensive--salaries for clerical personnel have already fallen 8% to 19% below national average wage levels, by occupation, according to the U.S. Department of Labor."

"Although office automation is described in futuristic terms, its goals and methods are essentially no different from the old, discredited factory time-and-motion methods which were used to organize industrial assembly two generations ago. Moreover, increased shiftwork and nightwork are growing more common, as employers seek to get the most out of their new machines. "Piece-rate work"--pay-per-line-of-information-processed--is spreading. Managers are using production quotas and constant monitoring of work performance to carry out speed-ups of awesome proportions in large clerical operations. Looked at closely, we see that the much-wanted "Office of the Future" is little more than a re-creation of the "Factory of the Past."

"As the introduction of office automation disrupts traditional clerical career paths, clerical jobs are becoming more dead end, or altered for the worse. A study of five large employers in New England found that when office automation was introduced, the proportion of low-level clerical jobs remained the same, and that existing clerical personnel were rarely upgraded to fill new skilled jobs. The study further found that the automated clerical jobs were more mechanical and narrow, and that 'the main career avenues for clerical workers were either horizontal or downward,' but not upward. (Foldberg and Glenn, 1977)"

"According to a recent study of Wall Street legal secretaries conducted by Dr. Mary Murphree of Columbia University, 'current innovations in office computerization are striking at the heart of the secretarial craft, and are creating a number of serious problems. These include a continued de-skilling, de-professionalization, demoralization and job dissatisfaction--all of which can be traced to the awkward and usually uncoordinated introduction of specialization and automation by these bureaucracies."

"There is increasing concern over the danger of "polarization" of the office employment structure due to office automation, with high technical skills and substantive knowledge at the upper-most level, large numbers of rote, deskilled workers at the base, and a vast skills and knowledge gap in between, which would be virtually impossible for any reasonable career ladder to bridge. (Menzies, 1980)"

"Sex and race discrimination are not only perpetuated, but made worse by the computerization of office work. Women are under-represented in the computer programming, systems and technicians jobs, while minority women in particular are concentrated into 'back office' data entry pools, often involving shift work. (Kraft, 1979, Garson, 1981)"

"Through automation, the more enjoyable aspects of clerical work--variety, contact with other people, natural rest breaks and changes in routine--are increasingly curtailed or eliminated. The more stressful aspects of clerical work--repetitive tasks, constant sitting, dead-end jobs, isolation, relentless work pace and continual deadlines--are all on the rise. The increased health risks associated with work at Visual Data Terminals (VDTs), and with automated offices in general are documented in Warning: Health Hazards for Office Workers (Working Women, April 1981, Cleveland),"

"In a study of work in the office for the purpose of recommending improved adaptation of word processing, anthropologist Dr. Eleanor Wynn found that 'in an office as it presently operates, the knowledge which is both the means and the product of the office is dependent on interactions between people for its quality, relevance and appropriateness. Office work is rarely recognized as a collective intellectual problem-solving activity; yet my study not only indicates that this is the nature of office work, but that this activity is focused at the clerical level.' (Wynn, 1980)

In other words, office work is the product of office workers' helping each other in problem-solving activities--especially in emergencies and for "exceptions"--through informal office networks and support systems, and using the office workers' specific knowledges about the organization. These realities collide with the closed office technology systems being developed today which take cognizance only of office procedures and not of work processes."

"Based on her study, Dr. Wynn makes the following recommendations on the development of new technologies:

1) That "the office environment be maintained as an environment that enhances human interaction and communication," rather than reducing these.

2) That "the amount of actual decision-making and conceptualizing that low-level employees do about their work be acknowledged" so that it "can take place explicitly and with license, rather than 'informally,' implicitly and sometimes even under cover--'against the rules', as it were." This recognition of clerical workers' role argues for "overt distribution of responsibility" in office automation systems, to reflect what people really do and how they really contribute to the work product.

3) Rather than sell systems that assume people operate according to pre-formatted communicational and procedural 'grammars,' systems should embody...the real capabilities that people demonstrate, providing workers with tools to manipulate the systems according to situational and historically developed requirements of their work as they see them unfolding in the process of doing that work; in short, office innovations should be introduced as tools people can use to extend what they do, rather than in ways that turn people into "extensions of the machines" or computer systems."

"Research so far tends to show that the net effect of word processing on productivity is not overwhelming, averaging about 2% a year (Vyssotsky, 1979). Furthermore, management attempts to justify rigid standardization of work procedures and computer-based monitoring and measuring of clerical work do not hold up. Recent research indicates that productivity often decreases with increased rationalization of work and managerial control over the pace of work. The main method of controlling the speed of work in computerized systems in offices is continuous, computer-based or computer-aided monitoring of work performance. A review of the research literature on machine-paced vs. self-paced work reveals that when the control over the pace of work is taken away from the worker..." errors tend to increase; error rates increase from 40% to 50% up to 400%, depending on the situation one is dealing with." (Beith, 1981). A study by the U.S. NIOSH, on the other hand, finds that both job satisfaction and performance improved when operators controlled their own work pace. (Cohen, 1980)."

"There are instances where innovations which would benefit clerical and secretarial workers (and others) have been held up in computer companies because these developments are not a top priority. Better and safer equipment, for example, to meet ergonomic standards,is being manufactured and marketed in Scandinavia, as a result of pressures on the computer industry brought to bear by European unions and governments. A report by the Department of Professional Employees of the AFL-CIO, based on a tour of Northern Europe to examine new office technologies, noted that:

> 'An interesting comparison can be made between the different types of VDTs (in use in Sweden). Those from the U.S. have green screens with lighter green characters and a minimum of adjustments, while the Swedish models were fully adjustable with a minimum of screen glare and easier-to-read yellow characters on a dark brown screen. Both models are made by IBM, the former manufactured in the U.S., the latter in Sweden.'

In closing, I believe it is important to recognize the urgency of the need to challenge and reverse the negative trends in office automation as it is being introduced today, and further to recognize the urgent need to develop alternative ways to put new office technology to use to benefit all workers. Computer industry analysts predict that in two years this will be a "frozen" technology, and that "within the next five years it will be too late" to undo adverse effects."

6th Witness--Travis Marshall, Vice-President and Director of Government Relations, Motorola, Inc.

"Many firms have made the mistake of selecting managers for their R&D organization on the basis of the candidates' relative skills as R&D scientists. Perhaps some have believed that the best R&D scientist would perforce make the best R&D manager. But others felt boxed into such decisions because it was the only way they could reward their most productive technician. At Motorola, we addressed this problem by creating what we call "the Technical Ladder"—a series of increasingly higher-level jobs to which a technician can advance on the basis of non-managerial contributions, and yet have equivalent status and rewards as someone proceeding up the management ladder, all the way to "Officer of the Technical Staff," the equivalent of a Vice-President.

We don't claim to have invented the concept of the "Technical Ladder," but we heartily endorse it. For many years, we have applied a similar concept on our assembly lines, and it too has worked very well. Just as the best scientist is not necessarily the best R&D manager, so the best assembler may not be cut out to be an assembly-line supervisor. When we find such a person, we cross-train them in as many possible tasks in that assembly operation, and then promote them to a position which we call "Key Operator." The Key Operator is like a utility infielder on a baseball team, only at Motorola, the 'utility infielder'--because of his or her versatility—is paid more than the more "specialized" first baseman or shortstop. In creating our 'Technical Officers' and 'Key Operators,' our objectives are to take advantage of and reward each employee's distinctive competence."

"The centerpiece of our people programs is our 'Participative Management Program,' or 'PMP.' Our Chairman has repeatedly expressed his conviction that Motorola does not have a single problem or deficiency to which someone or some group of people within the organization does not have the answer. It is our job as managers, he has told us, to provide an environment in which those answers will surface regularly and promptly. PMP is the means by which we have sought to create such an environment.

Under PMP, each work group meets regularly to discuss all matters relating to the employees work environment and their jobs. Supervisors answer all questions fully and completely, explaining management decisions in a way that lets employees see the rationale behind these decisions. At the same time, supervisors solicit the employees' ideas and suggestions for improvements. When solving a problem requires the cooperation of another work group, representatives of the two groups meet to work it out.

The PMP activities are tied in with group incentive compensation plans. The employees participate in setting their work groups' performance standards. When a group exceeds those standards, they are financially rewarded. It is clear to us, however, that it is more than the prospect of a larger paycheck that motivates our people, because they keep setting tougher standards for themselves."

7th Witness: Lloyd McBride, President, United Steel Workers of America

"In addition to economic and technologic considerations, the quality of the relationship between labor and management is--at all levels--an important factor in improving productivity. Labor-management cooperation is, at root, a matter of attitude. If the two parties seek conflict, they will surely get it. If, on the other hand, they try to solve problems, they will explore--and eventually implement--the mechanisms for doing so."

"In 1980, we began an experimental effort to directly involve workers in the plant--at the departmental or work unit levels--in discussions dealing with the full range of problems and possible solutions which are not addressed specifically by the language of the contract agreement between labor and management. In the Memorandum of Understanding on 'Labor-Management Participation Teams,' it is observed that:

> 'The parties recognize that a cooperative approach between employees and supervision at the work site in a department or similar unit is essential to the solution of problems affecting them. Many problems at this level are not readily subject to resolution under existing contractual programs and practices, but affect the ongoing relationships between labor and management at that level. Joint participation in solving these problems at the departmental level is an essential ingredient in any effort to improve the effectiveness of the company's performance and to provide employees with a measure of involvement adding dignity and worth to their work life.'

Under this new arrangement, routine job-related problems are dealt with through the normal grievance procedures and through contract negotiations. But there are a wide range of problems beyond grievances or negotiations requiring an effective channel of communications between workers and management that can contribute to the efficiency of the enterprise and the well-being of the workers.

The Participation Teams mark the beginning of an increased involvement by employees in their work and their work environment. They constitute a recognition that workers are more than "Hired hands" to be assigned a task like an automaton. In many respects they are more knowledgeable about production processes, the uses of equipment, and the quality output than their managerial counterparts. Workers are a source of expertise that managers have by and large failed to utilize. This is changing in the steel industry. Thomas Graham, President of J&L Steel Corp., stated his company's objective for Participation Teams:

> 'We want to encourage an open dialogue among employees and managers that will draw out new ideas. We want to give all employees the sense of personal involvement that can lead to more

dedicated and effective efforts.'

Several major steel companies, in concert with the union, have set up Participation Teams and more are expected to do so in the near future. Because of the short time they have been in existence, our experience with the Teams is limited. However, some preliminary successes are already evident.

This effort is being made with the full cooperation and support of the International Union. It is not an effort to circumvent the union. Recognition of the potential contribution that workers can make to the solution of plant and production problems is, I believe, a significant departure from traditional management attitudes in steel that bodes well for the future."

EXHIBIT 11

REBUILDING MATH AND SCIENCE EDUCATION: BUSINESS LENDS A HAND

By Margie Ploch

The nation's businesses are sending their technologists back to school—not to study, but to teach. Their goal is to breathe life back into precollege math and science education and hence to produce a new generation of talented scientists and engineers as well as a technologically literate public. What is at stake, claim business representatives, is nothing less than the technological leadership and economic health of the United States. "With international competition, the quality and numbers of engineering graduates are vital to us," says William A. Orme, secretary of the General Electric Foundation.

The importance of precollege math and science education came into focus when businesses began pumping money and equipment into college and graduate engineering education in order to ease the shortage of engineers. Companies found that the majority of students were (and still are) reaching college barely literate in science and math; according to the National Science Foundation, 75% of 1980 high school graduates were unqualified to take undergraduate courses in these disciplines.

Hence industry's college programs cannot realize their potential unless the problems that beset precollege math and science education are solved first. Foremost among them is the national shortage of qualified math and science teachers, so desperate in some states that teachers from other fields are filling in. Even if enough qualified teachers were available, however, the requirements for math and science courses would still be insufficient to prepare students for jobs in an increasingly technological society. Outdated and inadequate teaching materials, curricula, and equipment further cripple instruction. And school days in the U.S. are fewer and shorter than in many other countries. As a result, by the end of first grade, American children have already fallen behind their Japanese and Taiwanese counterparts in reading and math, according to a recent University of Michigan study.

Although there are some federal education programs, the Reagan Administration has advocated private sector initiatives as the means to revitalize math and science education. Businesses are responding by lending employees, and donating equipment and money to elementary and secondary schools for math and science education. Companies have sponsored programs to provide employee volunteers to enrich math and science courses, to recruit or retrain teachers, to create instructional materials and curricula that cover recent advances in science and technology, and to attract more students to engineering and technical careers. "A natural symbiotic relationship is emerging between industry and education," says Louis Robinson, IBM's director of industry relations. "Growth in technology depends upon innovation and creativity, and that relates directly to the quality of education in math and science."

Improving teaching

Teacher certification requirements usually prevent scientists and engineers from teaching full time in public schools, but many districts are eager to have volunteers supplement the regular curriculum. More and more companies, such as Kaiser Aluminum and Chemical Corp. (Oakland, Cal.) and Arco (Philadelphia), are giving their employees paid time away from work for these activities. Professional organizations, including the IEEE, are encouraging members to volunteer some of their time. And adopt-a-school programs, in which a business pairs up with a school, commonly involve company volunteers working in the school. Most of the more than 1000 Dallas companies that have adopted local schools send tutors to help individual students, especially in math, says Mary Brouillette, a spokesperson for the Chamber of Commerce. Xerox's Science Consultants Program in Rochester, N.Y., sends employees twice a month to local fourth, fifth, and sixth grade classes. The program stresses hands-on learning through the use of 400 instructional kits created by the consultants and supplied by the company. In the 15 years Xerox has supported the program, consultants have reached an estimated 11,000 children.

Retirees—recruited and organized by their former employers, like Dow Chemical (Midland, Mich.)—are also being tapped for math and science instruction. At one Pittsburgh high school, for example, retired scientists advise students in the laboratories, says Jane Burger, project director for the Allegheny Conference on Community Development (Pittsburgh).

Although few scientists and engineers have been trained as instructors, schools usually praise the quality of their teaching. In some cases companies formally prepare employees before sending them into the classroom. Xerox seeks out technical staff members who appear to have the ability to work well with children and teachers, then equips them with materials and outlines for lessons. And Project SEED, a math enrichment program, puts its instructors through a rigorous course before sending them into a classroom, says

Dallas-area director Hamid Ebrahimi. They learn the Socratic method of teaching by questioning, which Ebrahimi claims is the reason for Project SEED's success in teaching advanced math to elementary school students.

Originally designed by educator William Johntz to boost the academic achievement of minority students through success in math, Project SEED has been run in many communities with help from such corporate sponsors as Bell Labs and IBM. In Dallas, volunteers from Texas Instruments and Southwestern Bell are part-time staff members. An independent research report to the Dallas school board described Project SEED as "an excellent instructional system" that was likely to encourage students to take more advanced math courses.

Other business efforts to improve teaching focus on training and retraining math and science teachers. Many undergraduates who would make excellent teachers are lured into industry by the higher salaries. To attract these people to teaching careers, Digital Equipment Corp. and the Univ. of Massachusetts School of Education have created a 14-month master's degree program.

In addition to paid internships during the course, each graduate is guaranteed three years of summer employment at DEC. "We think that for people to have the wherewithal to become teachers, they need additional money," says Russ Johnson, DEC's manager of U.S. college relations. "And after they go through the internship, they have skills that can help us."

Although teachers are needed for science and math courses, other subjects are often oversubscribed, especially in secondary schools. Therefore, another approach that businesses are funding is to take teachers from other disciplines and retrain them, usually at a local university. For example, Arco, the Council for Basic Education, and the University of Texas at Dallas have supported a summer institute just for this purpose.

But even teachers certified in math and science may not have kept up with technological advances. According to the National Science Board Commission's report, hundreds of thousands of elementary and secondary school teachers need additional training in math and science. Elementary school teachers often lack the math and science background necessary to teach these subjects effectively. Furthermore, many secondary teachers who had adequate skills ten or twenty years ago are now foundering in the wake of technological change. Few teachers are hooked into the networks of industrial technologists who are using the latest techniques; worse yet, there is little contact between high school teachers and their counterparts at colleges. Consequently, many science museums are offering sessions to update teachers in science and math instruction. And the largest school districts in 25 states are now participating in IBM's computer literacy program; teachers attend summer sessions to learn how to use and teach with microcomputers the company has donated to their schools.

Retaining qualified and experienced math and science teachers has proved increasingly difficult. Awards, fellowships, and summer jobs—many of them sponsored by businesses—are ways of recognizing the best teachers and, in some cases, increasing their incomes.

This year the Los Angeles Educational Partnership organized an ambitious summer program with support from Arco. Thirty-five outstanding math and science teachers, selected by their peers, attend a two-week symposium, consisting of seminars conducted by leading technologists and tours of sponsoring companies. Afterwards fellows lead workshops at their own schools to share what they've learned with their colleagues. "We're trying to put these people in contact with resources in industry, then get them to help improve other teachers," says Partnership director Peggy Funkhouser.

Summer jobs in industry help science and math teachers learn about advances in their fields.

THE STANDARD OIL COMPANY (OHIO)

One proposed means of retaining teachers is differential and merit pay for master teachers and teachers of technical subjects. Such a scheme, however, conflicts with traditional tenure systems, through which teachers are promoted and paid according to the amount of time they have worked in the school district. Differential pay schemes now being tried by some states and local districts provoke teachers' fears that prejudice and preference will inevitably play a part in evaluations.

Yet businesses, because they are independent from the public education system, can skirt the burdensome bureaucracy that has sometimes blocked changes. Many compaines sponsor programs to selectively reward and encourage teachers. For example, Ciba-Geigy (Ardsley, N.Y.) offers $1000 annual awards for science teachers at all levels. And Honeywell (Minneapolis) has just begun a program of summer jobs for local math and science teachers that it hopes will benefit both teachers and the industry people they work with. Teachers will gain experience in industrial research and will develop contacts in the technology community, while Honeywell employees will learn more about the methods and difficulties of teaching.

G. Donald Long, chief scientist of the company's Physical Sciences Center, hopes that friendships made during the summer will help bridge the gap between schools and industry. "There is no mechanism for bringing people together," he observes. "We're trying to create that." A similar summer-jobs program, the Cleveland Teacher Internship Program, has worked so well that one sponsor, Standard Oil (Ohio), plans to increase its placements from 25 to 100 per summer by 1985.

Career education

Better teaching and materials alone may not influence enough students to pursue advanced studies in math and science. To fill their own future needs for technologists, businesses are pushing career education—especially for minority students, the group least likely to enter scientific fields. "We have to convince kids in seventh, eighth, and ninth grades not to opt out of scientific and technical careers," says GE's Orme. His company is pumping $1 million a year into programs across the country to encourage minority youth to pursue math, science, and technology careers.

Some companies develop career education materials, and others sponsor field trips to their offices so that students can see "engineers at work." But most programs depend on visits to schools by company volunteers. Scientists and engineers who visit classrooms serve as role models and are important in influencing students to pursue similar careers. "We try to identify interested and talented kids, encourage them, and set up programs to help them succeed," says Orme. A similar program, METCOM (Metropolitan Consortium for Minorities in Engineering) in Washington, D.C., organizes volunteers from industry and government labs to give high school students presentations on engineering jobs. Board member Marilyn Berman, assistant dean of the College of Engineering at the Univ. of Maryland, believes that METCOM has helped increase minority participation in engineering programs at her school.

Hap Vaughan of Texas Instruments is a volunteer teacher in Project SEED, an elementary school math enrichment program in Dallas.

DALLAS CHAMBER OF COMMERCE

Schools for math and science

The most ambitious collaborations between businesses and education are embodied in high schools devoted to math and science. Such schools are being established in cities and states across the country, and businesses have speeded their growth. The North Carolina High School of Science and Mathematics, for example, is a statewide residential public high school. Students who have shown exceptional talent attend for their last two years of high school. The school has received $7.5 million in funding from private sources, including IBM. Since it graduated its first class in 1982, the school has produced over 160 National Merit semifinalists, the highest percentage of recipients at any school in the country.

Three years ago, Honeywell and the Minneapolis school district set up Summatech, a "magnet school" (one that draws students from an entire metropolitan area). The company put $40,000 into the pot, and provided the services of 62 volunteers (mainly scientists and engineers) in the planning year, says Rita Kaplan, Honeywell's manager of education programs. Employee volunteers continue to teach special classes, give career education presentations, and advise the teachers and administration, according to Honeywell's Long, who oversees the company's involvement in Summatech. To graduate from Summatech, a student must pass four years of math and science, and two of computer science, as well as courses in humanities and social sciences. Honeywell is also funding a program to enrich math and science at a Minneapolis elementary school, says Kaplan.

Xerox and IBM will each lend a staff person full-time to the planned School of Science and Technology (Fairfax, Va.) to assist with preliminary fundraising efforts, says superintendent of schools William J. Burkholder. In addition, the school is looking for lab equipment donations and staffing help from industry. "We expect to depend on business to a great extent for people who have specific abilities in areas we'd have trouble finding among the pool of teachers," he explains.

Because of the school's status as a governor's magnet school for science and technology, Burkholder believes that the state will "let us waive or alter certification requirements, although this would be done on an individual basis." Such special teachers will complement the regular faculty, Burkholder says, and the school will provide whatever in-service training and support they need.

Partnership structures

The framework for collaboration between businesses and schools usually takes either of two forms: one-on-one or systemwide. In either case the partnerships may be established through intermediaries.

One-on-one programs, commonly called adopt-a-school, were especially touted during 1983–84, which President Reagan declared the National Year of Partnerships in Education. Local chambers of commerce often help organize "adoptions" within their area by matching a school (or magnet school-within-a-school) with a business. The most successful relationships, says Honeywell's Kaplan, are those that are carefully tailored to the needs of the school, business, and community.

While businesses may contribute money to sponsor special activities or donate equipment (especially for labs in science classes), most partnerships emphasize the human resources the firm can share with the school. In fact, the value of volunteers' contributions to math and science education may far exceed a company's monetary donations. The Chicago Adopt-a-School program, says director Al Sterling, asks not for money, jobs, or equipment, but only for people. Because volunteers are usually highly motivated, he adds, they will often bring the equipment and money with them if they see a need for it. In turn, the volunteers feel good about giving their skills to the community. "The morale of the staff goes up," Sterling says. "It's the first time that many of these people are asked for anything beyond their job description."

In contrast to such one-on-one partnerships, businesses may work with an entire school district or with districts across the country. MathCounts, sponsored by the National Society of Professional Engineers (NSPE), the National Council of Teachers of Mathematics, the CNA Insurance Companies, and the National Science Foundation, is one such program. During the 1983–84 school year, 400,000 seventh and eighth grade students from 47 states and the District of Columbia learned advanced math skills from materials created and provided by the sponsors. The best students in each class competed in school, regional, state, and national contests. Next year, says Leslie Collins, a spokesperson for NSPE, the program will double in size and include students from all 50 states.

Partnerships and systemwide relationships may be brokered by private foundations, as well as state and federal agencies. California alone has over 100 such private foundations, according to a National Alliance of Business report. The intermediaries try to match schools' needs with corporate donors' resources. They also provide the continuity and motivation necessary to start and maintain successful partnerships, says Gladys Thatcher, director of the San Francisco Education Fund. Her organization is a community-based nonprofit group working with about 70 companies in creating programs to benefit the San Francisco public schools.

Financial support

All of business's contributions to schools amount to a tiny fraction of total U.S. educational expenditures. But their dollars and volunteers are usually more mobile than public funds and personnel. "Private dollars can be flexible and quick, and they should be spent where public money can't or won't go," says David Bergholz, president of the Public Education Fund (Pittsburgh), a national organization that helps establish educational partnerships.

While private sector funds usually pay for programs that enhance the standard curriculum or activities, the burden of financing public schools has traditionally fallen to taxpayers. Business partners, however, are beginning to contribute more directly to school budgets.

In North Carolina, for example, the state legislature insisted that the majority of operating and capital expenses for the state's School for Science and Mathematics be drawn from the private sector, says Mark Leuchtenberger, assistant development officer for the school. As a result, the school is continually soliciting money from businesses and foundations. "Our ability to raise money from the private sector is a measure of our quality and the respect we are accorded," Leuchtenberger explains. "If we can't generate income, we're not doing what we're supposed to do."

Businesses' contributions to schools are ultimately self-serving in that they produce more qualified workers. Giving resources to local schools also strengthens the company's image and the community's economic base. "The important issue in business/school relationships is not just dollars but making closer contact so that business knows what's going on in the schools and becomes a supporter of public education," the Public Education Fund's Bergholz explains.

For the partnerships to be effective, they will have to last. "It's going to be a long haul, maybe 10 years," says Peggy Funkhouser, director of the Los Angeles Educational Partnership. Funkhouser's organization stresses funding of at least three years for its projects, and tries to make them self-sustaining. "We are always trying to get successes built into the system or get them to stand on their own," she says, "so we don't have to keep raising funds."

Margie Ploch is managing editor of HIGH TECHNOLOGY.

LEARNING WITH TECHNOLOGICAL TUTORS

By Dwight B. Davis

Educators have a problem. The world is changing so rapidly, propelled in large part by the proliferation of new technologies, that conventional teaching methods that were developed to cope with an earlier, relatively stable environment have become obsolete. Appropriately, educators are turning to technology to improve teaching of both children and adults in this technological age.

Central to this trend are low-priced microcomputers and a blizzard of educational and training software. Almost 98% of the country's 9272 school districts with more than 600 students now have at least one microcomputer for classroom instruction, according to a survey conducted last April by Quality Education Data (Denver), a market research firm. Many of these microcomputers were donated by manufacturers, but schools nevertheless spend 20% or more of their materials budgets on educational software, or courseware.

At the adult level, a major shift is occurring away from instructor-taught seminars toward individualized, computer-based self-study. Accelerating this trend is the use of laser videodiscs; when linked to microcomputers, they can serve as highly interactive tutors that operate at a level and a pace suited to each individual's needs. Other technologies that promise to play growing roles in educational systems include speech synthesis and recognition and various implementations of artificial intelligence, including expert systems.

Some people view technological aids as panaceas that will eventually prove better than human teachers in most situations; others have a strong aversion to any use whatsoever of computers in educational settings. Between these two extremes are the majority of educators, who believe technology can play an important part in teaching, but only as a set of tools for competent, well-trained instructors.

But there are many unanswered questions about how and when computers and related systems can best be used, especially at the primary and secondary school level. Pressured by parents and a widespread computer mania, many schools have rushed to acquire the machines in what critics term a "buy now, plan later" approach. The introduction of computers into a classroom inevitably displaces part of the existing curriculum, and there is little agreement about what subjects should be sacrificed.

Complicating matters further, some educational software doesn't provide much beyond what is already achievable with noncomputerized teaching techniques. Although courseware is growing in sophistication, becoming more interactive and adding such features as simulations of natural phenomena, the bulk of the programs are of the drill-and-practice type. Given the costs involved, using computers simply as "electronic page turners" or "electronic flash cards" is often difficult to justify. "Much of what initially happened with computer-aided instruction was merely translation of print media onto computers," notes Roger Orensteen, director of industry marketing for high technology at Wilson Learning (Eden Prairie, Minn.). "There was no new dimension of learning at all." But just as the early automobile gradually lost the trappings of the horse-drawn carriage, rote learning by computer is slowly fading as new ways to present material begin to explore the technology's potential.

Learning about learning

Before educational technology can fully be exploited, however, much remains to be discovered about the learning process in both children and adults. Wilson Learning, which develops and runs training programs for corporations, has established an alliance with the University of Minnesota's College of Education "to conduct research into how adults learn and how technology can aid learning." Various programs are also studying learning in children and trying to establish a role for technology in that process. Harvard University's Graduate School of Education, for example, has a $7.7 million contract from the National Institute of Education to explore how computers and other technologies can improve the teaching and learning of science, math, and computers from kindergarten through grade 12.

Both the Wilson Learning and the Harvard programs recognize that a better understanding of the nature of learning is a crucial first step in determining how technology can best fit into the educational picture. "The fundamental thesis that shapes everything we're doing," says Judah L. Schwartz, codirector of Harvard's Educational Technology Center, "is that if you're going to explore the ways in which technology can be useful in science and math learning, you'd better first find out what's hard about science and math learning."

In a perfect world, complete knowledge about the learning process would precede all attempts to improve teaching—a situation that clearly doesn't exist. Rather, technological teaching aids will be used in a variety of ways, some of which work, some of which fail. This process, in turn, should add to our insight about how learning occurs. But even when learning improves in the presence of computers, it's not easy to discern which improvements are directly related to the computers and which to other factors, such as better teacher training. "Education is just too muddy a business to be able to put your finger on *the* element that makes the difference," says Schwartz, who is also a professor of engineering science and education within MIT's School of Engineering.

While hard statistics are difficult to come by, several studies have indicated that computers can aid learning. A 1982 Office of Technology Assessment report states, "There is a substantial amount of agreement that, for many educational applications, information technology can be an effective and economical tool for instruction."

Many believe that a large part of the computer's success in education lies in its novelty and its intrinsic allure. Many educational software vendors, recognizing the power of video games to rivet youngsters' attention, are trying to incorporate gaming features into their packages. Some observers fear, however, that the teaching potential of computers may diminish as the machines become more commonplace and their novelty wears thin. But if courseware is properly designed, says Schwartz, computers should retain their allure much as books continue to attract readers.

Even though the debate about computers in schools has largely shifted from "Should we use them?" to "How do we best use them?" plenty of controversy remains. There is disagreement about how to evaluate the educational software inundating the market, about whether computer use by very young children discourages active play, and about whether to teach programming and computers as subjects unto themselves.

A particularly stormy controversy surrounds the choice of a programming language, if one is to be taught. The Basic language, long a leader in educational settings, has come under fire from proponents of the more sophisticated Pascal language and from others who favor the more flexible Logo. Developed almost 20 years ago by Seymour Papert and others at Bolt Beranek and Newman (Cambridge, Mass.), the graphics-oriented Logo language has attracted much support because it is not only easy to learn and fun to use but also very powerful in establishing student control over the computer and in teaching logical thinking.

Such secondary benefits are as important to some as the actual programming skills acquired. "I believe that learning to program is important because it is the best way to get in touch with how the idiot machine works," wrote Steve Bergen, codirector of The Teaching Company (Brookline, Mass.) in a recent issue of *Independent School*. "Additionally, learning to program in any language involves considerable logical, intellectual, and aesthetic skills—certainly the domain of education."

Adult training

Although the use of computers in classrooms still stirs debate, their presence in adult training situations has become generally accepted. Control Data (Minneapolis) pioneered computer-based training with Plato—a mainframe computer-based educational system developed in the '70s at the University of Illinois. Plato boasts a collection of educational programs that, today, is probably the most extensive in the world. This library of courseware has recently been made more accessible through the introduction of Micro Plato, an implementation of the system on microcomputers. But lately, such text-oriented training systems have been eclipsed by the newest technology on the block—interactive videodisc.

As more young children use classroom computers, questions arise about the machines' impact on developing minds, social abilities, and physical activities.

THE LEARNING COMPANY

Laser videodisc players and their associated media are best known as a movie-presentation technology for home TVs. When the players are linked through controllers to microcomputers, however, they can become powerful teaching tools that combine video images and audio instruction with text and computer data. Because the players can quickly access any location on the videodisc platter, designers can produce systems that let students jump between subjects and levels of difficulty according to their individual needs. The resulting improvements in learning can be astonishing, claim the technology's proponents.

Bringing the interactive video component to computer-based training "is as dramatic as the addition of sound to movies was," says David A. Lubin, cofounder of Interactive Training Systems (Cambridge, Mass.). ITS, which has produced over 100 training videodiscs for corporate clients, recently formed a joint venture with Advanced Systems (Arlington Heights, Ill.) to develop a highly interactive videodisc/computer system. "We believe the marriage of laser videodiscs with personal computers will be ubiquitous by the end of the decade," Lubin says.

One of the prime benefits of videodiscs in training situations, according to Lubin, is that interactive video, run by each student at a personalized pace and level, helps keep the student's attention. "In a conventional learning environment," he says, "students spend 25 to 50% of their energy just trying to stay focused on the presentation."

Lubin claims that by using videodisc systems, ITS has been able to compress the time needed to learn any given curriculum—by factors of as much as six to seven—while improving the retention of the learned material by up to 40%. In addition, the computer can closely monitor each student's capabilities, and can slow course progress and postpone completion if the student isn't learning adequately. Finally, interactive videodisc training costs considerably less than conventional training methods—a crucial point for cost-conscious companies. "The cost of live instruction runs approximately $250 per student per day," says Lubin, "whereas our videodisc systems cost only about $50 per student per day."

These benefits will bring major changes in the business of training adults, says Gary Quinlan, executive VP at Wilson Learning. Today only about 10% of Wilson Learning's programs are of the self-study variety. But a survey performed by the firm's parent company, John Wiley & Sons (New York), indicates that the Fortune 500 companies expect as much as 50% of their training efforts to use some sort of individualized interactive technology within five years.

Smarter systems

A still-embryonic area of educational technology is artificial intelligence. Broadly, AI involves the programming of computers with traits normally associated with human intelligence; thus its possible applications in the teaching world are many and varied. ITS is exploring AI in hope of enabling the computer to take into account the background and the skills of each student. "We expect that AI will make the system smarter about who you are and how you want to see things," says Lubin. ITS also hopes to use AI techniques to shorten the time required to produce new training programs. "At some point," predicts Lubin, "the developer will just give the course content to the system, and the system will devise how to teach the material."

One of the most active areas of AI today is that of expert systems, which catalogue the knowledge of human experts along with the rules and procedures they use to exploit that knowledge. Some foresee the development of expert teaching systems. But even expert systems not specifically designed for teaching are usually well-suited to educational uses, says Thomas P. Kehler, executive VP of technology at IntelliCorp (Menlo Park, Cal.), a producer of expert systems and related developmental tools. "Expert systems usually have an 'articulation' facility that explains why the system did what it did," he says. Students who don't understand a process can therefore query the system.

If used properly, the various educational technologies won't just expedite the learning process, they will alter its very nature. Conventional learning involves the acquisition and long-term retention of specific knowledge. But in a world where most of an engineer's training becomes obsolete within about five years, such "maintenance" learning won't suffice, says Wilson Learning's Quinlan. Rather, the company argues, education should shift its emphasis toward "anticipation" learning, which better prepares students—child or adult—to adapt and modify their knowledge as circumstances require.

While people of all ages might benefit from such an educational shift, Wilson Learning expects children to find changes in the learning process easier to adapt to than adults. "Our task in training adults is much harder," says Orensteen. "People who are established in their careers or views have a significant amount of unlearning to do before they can make new connections." And he believes that technology has a major role to play in rendering such training effective. "It can help create a compelling way," he says, "for learners to challenge their own beliefs in private."

Dwight B. Davis is a senior editor of HIGH TECHNOLOGY.

For further information on the Special Report see RESOURCES *on page 111.*

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